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THE WESTERN NATURALIST

A Journal of Scottish Natural History

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THE RENFREWSHIRE NATURAL HISTORY SOCIETY

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RENFREWSHIRE IN PREHISTORY: THE IRON AGES

By FRANK NEWALL
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Renfrewshire Natural History Society

The Iron Ages saw the culmination of the advance towards tribal organisation promoted in the Late Bronze Age.

In Britain this was imposed, by invasions from the Continent, upon peoples probably so grouped territorially as to readily accommodate regional domination.

The palisaded hilltop enclosures, some, at least, of which were intrusive upon the Late Bronze Age, were replaced by a new concept, the timber-laced rampart, where a rubble wall, enclosed between stone faces, was braced by wooden tie-beams; either passed through the wall transversely at regular horizontal and vertical intervals, as in the large forts in the Abernethy area, (*Note 1*); or secured fore and aft to timber uprights, which were also braced laterally to form a box-work, against which the revetting front and rear walls were built as the interior was filled with rubble. Such was the construction at Craigmarloch, Kilmacolm; apparently at Auldhill, Portencross, (*Note 2*); and probably at Knock Hill, Largs. (RNHS, DES, 1969, 12-13).

The weakness of these forts lay in the gateways of massively constructed timber frames with defending towers or guard houses. If these were fired by accident or intent, the timber lacing within the walls acted as an updraught furnace, and at c.900° - 1200° centigrade the rubble interior fused and melted, thrusting the supporting wall faces outwards. The result is known as a "vitrified fort" (*Note 3*).

It is certain that vitrification was never the intention of the fort occupants. Were it so, then the task of hewing, cutting, and fitting the 400-600 trees required to construct the ramparts would render these the costliest bundles of firewood in history.

It is most probable that, in a heroic age when a king had to be seen to be a king, attended by his "druid" and court coterie, apparelled in bright colours and wearing appropriate symbols of rank, territorial acquisition was a criterion. As it is no longer possible to hold responsible for the destruction of the "vitrified forts" either the Broch people or the Romans, inter-tribal warfare is the logical explanation.

Apart from certain recognisable Early Iron Age objects, it is possible to distinguish in the west an intrusive ceramic element, Dunagoil Ware, which arrives with the "Late Bronze Age" palisades, and there appears to be a much greater use than on the east coast of hard black shale for rings and armlets.

Distinct from the timber-laced ramparts are palisaded banks in which earth or turf ramparts were fronted by stockades revetted by a fore wall. These at Walls Hill and Knockmade may be compared with Iron Age A forts in South England but at both sites Dunagoil ware was used. Indeed it is extremely difficult in the earliest phases of the "Iron Age" to attempt to establish contacts with England. Common elements may derive from common Continental ancestry.

While it might be reasoned that the Scottish timber-laced forts are earlier, the palisaded banks having arrived later from England, on grounds of diffusion; or equally, on grounds of typology that the palisaded banks ought to be earlier, as yet, despite the number of "chronological" datings advanced by the Carbon 14 method, it may be safer to suspend judgment.

The type site in the west, Dunagoil, a vitrified fort producing the pottery named after it, may be compared with the neighbouring Little Dunagoil. There the initial phase was stockaded with a massive retaining wall face built downslope. From within a secondary stone wall base and from associated cobbling came fragments of a two-valve clay mould for an Irish socketed bronze axe, accepted as debris from the initial occupation (*Note 4*). Nevertheless, Dunagoil ware was present in the primary level, as was the case at Craigmarloch in an occupation level sealed by the later vitrified wall, but equated with the primary doubly palisaded enclosure. Here we appear to intrude into the "Late Bronze Age" and move into the "Early Iron Age".

Whatever the relationship of the types of fortification of the earliest phase, tribal territories are indicated by the existence of very large fortified enclosures or Tribal Capitals. Walls Hill, Howwood, of 18½ acres contained two Iron Age occupation levels, the earlier supporting timber huts, the later stone based houses, possibly of the Damnonii. Traprain Law, of 32 acres, later the tribal capital of the Votadini, by its very size, shows that it was a tribal centre from its beginnings in the Late Bronze Age.

Beyond the forts the large round houses persist. Often they lie within homestead enclosures, perhaps of wealthier farmers. At least one crannog, at Bishop's Loch, was occupied in the earlier period, and poor relations still occupied caves.

In the later pre-Roman Iron Age, immigrants or refugees from England impinge upon the Scottish scene, perhaps as desperate displaced bands attempting to carve out new territories. While some appear to have advanced from the Midlands, and especially north-east England, there is evidence of a movement into the Western Isles and coast from the south west (*Note 5*).

Multivallate forts appear, and in the west there is a confusion of construction. Among the varied builds are simple duns, some merely ring forts, others large homesteads, others true forts, but all enclosed by a single thick stone wall. They may occupy hilltops, isolated inland ridges or crags, or, as "Cliff Castles", lonely promontories.

Others contain chambers within the thickness of the walls either as guard cells at the narrow entrances, or elongated as galleries, at times with stairways indicating upper structures. The gallery may continue throughout the entire circuit of the wall.

Occasionally a single straight galleried barrier, as at Port Froige, Islay (F. Newall, DES 1963, 12-13), cuts off a headland.

The ultimate form, architecturally, is the broch, a tower based on a wall c 20 ft. thick, which encloses several superimposed galleries, each reached from the lower by a staircase within the wall.

Very small "stack forts"; heavily stone walled duns built on islands, often reached by stone causeways; crannogs with similar approaches; and caves almost completely blocked by massive walling of dun-like proportions, all indicate troubled times and the need for refuge. Of four Clyde crannogs or artificial islands, at Dumbuck, Old Kilpatrick, Langbank West, and Langbank East, the last is dated to the second century A.D. (*Note 6*).

Although the duns and galleried structures are of a western and northern province, duns and brochs penetrate to Fife, along the Central Lowlands, and into Ayrshire and Wigtownshire. Recently a small galleried structure was recorded at Black Law, north of Stewarton (A. Hallifax Crawford; W. Lonie; F. Newall; DES 1957, 13: 1970, 18), on the site of an earlier fort; and a massive tumble or "cairn" on Creuch Hill, may be the ruins of a ring fort.

While many small sites were merely for refuge as the paucity of finds indicates, from others, from casual finds, and from votive offerings, one catches a glimpse of the increasing affluence and barbaric splendour of the Later Iron Age; in a fund of enamelled

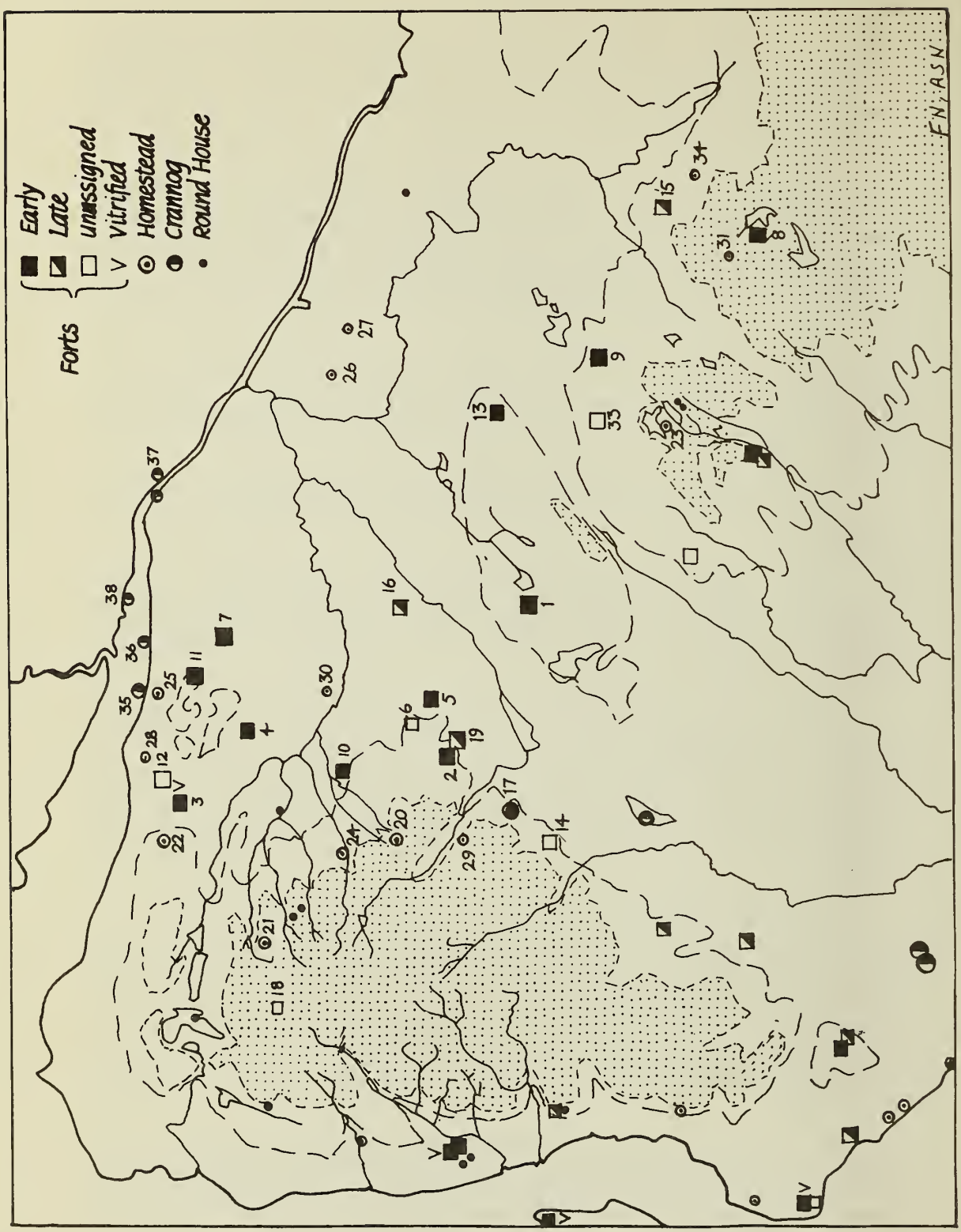

Figure 1: Fortifications and Settlements.

brooches and horse-trappings; spirally enamelled stone beads, glass beads and armlets with vari-coloured glass inlays or applications; and especially in the highly sophisticated decorated metalwork embossed or engraved in abstract curvilinear design. We may compare with the design of the well known Birdlip and Desborough mirrors, the "horns" of the Torrs Chamfrein, now interpreted as a pair of drinking horn terminals lately affixed to a decorative pony cap (*Note 7*). One confesses to an incongruous image of Celtic ponies indulging in a drinking bout, and wonders if, in the context of a votive offering, the "terminals" might not better assume the role of chariot fittings, either as mounting handles (Cf. Lynn Cerrig Bach), or as rein guides.

Of ritual sites there is as yet little evidence in Scotland, although a carved wooden effigy from Ballachulish Moss (*Note 8*), reminds us that such figures, either in wood or as monoliths sculptured as human heads, had replaced the standing stones of an earlier age (*Note 9*).

RENFREWSHIRE SITES

FORTS

1. Walls Hill, Lochwinnoch, NS41055873 - 41355889 - 41105902 - 41105853.

Tribal Capital. A fortified inland promontory of 17 acres, with a lower defended terrace c.1½ acres on the north east. The primary rampart comprised a stone platform flanked by a stockade. A primary timber hut, partly trench founded, contained sherds of Dunagoil ware. Later the rampart was refaced and stone based houses overlay the primary huts (F. Newall, *Excavations at Walls Hill, Renfrewshire*. Paisley 1960).

2. Knockmade, Lochwinnoch, NS35236184

The primary rampart was a mound of layered turf fronted by a stockade and revetted by rough walling. Dunagoil sherds were recovered. The fort was larger than the later stone walled homestead, containing stone based round houses, and measuring 124 ft by 66-82 ft within the 8 ft wide circuit wall.

(*Paisley Magazine,* Oct 1828, 524. *Cairn of Lochwynyoch* mss. X, 2: XI, 115. *Archaeological and Historical Collections of the County of Renfrew,* Paisley, 1890, II, 210-11, with plan). Excavated by Robin G. Livens, 1959, 1960, 1967. (DES 1959, 32-3; 1960, 34-5).

3. Craigmarloch, Kilmacolm, NS344718 (36)

The fort topping an isolated crag measures 163 ft by 77-87 ft over a 10 ft thick wall which is vitrified for some distance on each side of the 5 ft wide west entrance, and at the north west corner.

(A.S. Gibb, *Much About Kilmacolm,* Glasgow, 1872, 69-70. A. Hallifax Crawford; F. Newall, 1953). Excavated by Helen C. Nisbet, 1963-65 (DES 1963, 42-3: 1964, 47; 1965, 34; 1966, 39).

The wall contained inner and outer rows of vertical posts set in bedding trenches and secured by horizontal cross-ties. There was some evidence for a median line of uprights. Annexes lie at lower level along the north east and south west flanks of the fort. An artificial fox-earth against the south wall of the fort was constructed by a former proprietor, Major Collins.

4. Elphinstone Wood, Houston, NS375699

A stone kerbed rubble walled fort occupying a precipitous sided crag, with entrance in the less steep south east side. A lower annexe lies on the east. The fort measures 200 ft by 89 ft. A low scarp 73 ft from the north end may indicate a division wall (A.S. Newall, DES 1966, 39).

5. Marshall Moor, Kilbarchan, NS372626

Occupying a precipitous ridge, a fort 310 ft by 160-170 ft, stone walled with outer ramparts enclosing small annexes on north and south. A stretch of walling within the fort along part of the west side may be secondary. The wall is 12 ft wide, increasing to 16 ft at an apparently stepped or buttressed stretch. The entrance is probably in the north end, communicating with a small lower hill terrace. There is the trace of a timber hut in the north east (R.W. Feachem - Marginal Lands Survey, 1954).

6. Castle Hill, East Barneigh, Lochwinnoch, NS37056305

The east end of the hill is cut off by a deep depression. A rubble mound, much spread encloses the area beyond (R.W. Feachem - Marginal Lands Survey, 1954).

7. Barbeg, Erskine, NS40407112

Known locally as the Witches' Hill.

A stone walled fort, 100 ft by 86 ft, extended by annexes on east and west to a total length of 160 ft. Small terraces on north and south east may also have been annexed. The 8-9 ft thick wall has entrances in the west and south, the former a

typical rock cut inturned access. (A. Hallifax Crawford, 1964).

8. Dunwan, Eaglesham, NS547489

An oval univallate fort, 280 ft by 176 ft over a turf and stone rampart, 23-25 ft wide, expanding downhill to 40 ft wide on each side of the south entrance. There are traces of annexed defences round the foot of the hill. Within the fort are the hollows of at least two timber houses. A terraced approach way at least 30 ft wide runs south west for some 600 yards from the entrance (A. Hallifax Crawford; F. Newall, DES 1958, 31).

9. Duncarnock, Mearns, NS502559

A strongly built univallate fort enclosing almost 5 acres with terrace fronted wall crossing the plateau on the south where the entrance is approached by a stone lined road. The other three sides are walled round the edge of the cliff. Along the foot of the east cliff is a possible annexe. A rocky rise at the north west corner is independently fortified, enclosing 110 ft by 80 ft. From this area came a sherd of Dunagoil Ware and a worked fragment of hard black shale (R.W. Feachem, Renfrewshire marginal lands survey, 1954; A. Hallifax Crawford; F. Newall, DES 1958, 31).

10. Castlehill, Gibblaston, Kilmacolm, NS34586605 (35)

A claviculate crag fort, 206 ft by 160 ft north of, and 135 ft south of the east entrance. On the north and west the wall is stepped or buttressed, 5 ft plus 6 ft wide. Elsewhere it is a turf mound 18 ft wide.

A wide depression on the south cuts the site off from level ground beyond. Within, on this side, stretches of rampart subdivide the interior. One large house measures 40 ft by 30 ft, and there is the suggestion of a second just within a secondary entrance in the north (W.O. Black; F. Newall, DES 1959, 32).

11. Barscube Terrace, Erskine, NS39077105

A 20 ft thick rampart encloses 248 ft by 210 ft. Within is a large round house 55 ft by 52 ft, the vestiges of a second, and crop mark indications of hut bases or storage pits (Elizabeth Main, DES 1971, 36).

12. Castlehill, Leperston, Kilmacolm, NS35057228 (37)

A claviculate fort, 102 ft by 74 ft north of, and 54 ft south of the east entrance. The interior is divided centrally, east - west, by a line of boulders with faint traces of associated walling. From the south end a wall runs south to join an

outer wall covering the south west quarter. There are further traces of outer walling on south and east (H.M. Sinclair; F. Newall, 1948; W.O. Black; F. Newall, DES 1959, 32).

13. Brown Hill, Neilston, NS478594

A claviculate fort, 104 ft by 52 ft and 44 ft, south and north of an over-lapping inturned entrance. One "round" house measures 44 ft by 34 ft. A terrace at lower level on the south-east has been walled. The site was used later, apparently in Mediaeval and 18th - 19th century periods (A.R. Pollock; W. Lonie, DES 1963, 46).

14. Castlehill, Glenlora, Lochwinnoch, NS32355875 (32)

The northern, higher, end of the hill, which is defended naturally by sheer sides, is cut off by a low spread rampart 18-21 ft wide, curving across the south and along the east side. Further traces appear on the north west. The "cairn" on the summit of the hill is perhaps part reared from the remains of a faintly outlined circular build 48 ft to 51 ft in diameter. This was tested with the probe. *Note* - The outcrop on the hill readily weathers into cups, and there are numerous examples (A. Hallifax Crawford; F. Newall, DES 1960, 32).

Of the above sites Nos 1-5 and 7-9 are undoubtedly early, 6 is unassigned, while 10-14 are also undated but despite their fortified appearance may be large homesteads rather than forts.

The only large late forts in our area are Castlehill, above Largs and Carswinning, Dalry.

The following small "forts" are late:

15. Castlehill Wood, Bonnyton, Eaglesham, NS554531

A small ditched fort, recorded by Ludovic Mann. Possibly a homestead.

16. Bar Hill, Kilbarchan, NS41006366 (39)

O.S.A. "A circular Danish encampment". N.S.A. 67 - "a small semicircular fort - rampart of stone now not exceeding 3 ft in height". From local information, within the fort a low turf circle could be seen. Aerial photographs show the suggestion of ditches. Possibly the "antique capelle" of Reg. Pas. 48-9 (fo. XXXII). Now almost erased by quarrying. Possibly a homestead.

17. Dunconnel, Lochwinnoch, NS331595 (31)

An inner enclosure, 44 ft in diameter bounded by a low

spread mound of earth and stone is contained within a circular enclosure, 130 ft in diameter, similarly walled. A further broad rampart encloses the foot of the hill on the east (R.W. Feachem, Renfrewshire marginal lands survey, 1954). Following a hill fire which burned out the south east quarter of the site, rain wash and sheep trampling brought to the surface a number of finds. These included fragments of rings and bracelets, not only of the customary hard black shale, but also of a softer blue variety. Of 104 sherds, while some resembled Dunagoil ware, many were of a lighter surface, even yellow and white, while one sherd was impressed diagonally with finger tip fluting. Other finds included a stone ball, knife marked bone, a fusiform blue shale bead, a discoidal serpentine bead, and stone discs. (*The Cairn of Lochwynyoch* mss, X, 2: XIII, 52. A. Hallifax Crawford; R.C. Scott; F. Newall, DES 1956, 22; 1961, 44). Certainly a homestead despite its defensive situation.

18. Creuch Hill, Kilmacolm, NS266683 (39)

On the south spur, detached from the hill proper by a wide depression, a massive "cairn" or tumble of heavy stones, many roughly squared. Despite interference by successive builds of fanks on the periphery, a circular foundation, 60 ft in diameter can be traced. Possibly a small ring fort or dun (R.C. Scott; F. Newall, DES 1957, 29).

The following are undoubted homesteads, i.e. large round farm houses, enclosed by defensive yard walling. Nevertheless as all are defended sites they are numbered consecutively.

19. Knockmade, Kaims, Lochwinnoch, NS25236184 (30)

A stone walled homestead enclosure. See No. 2 above.

20. Gotter Burn, Cat Craig, Kilmacolm, NS323644 (29)

a. A round house, 22 ft 6 ins within a 6-10 ft thick boulder kerbed wall with annexed chamber, is surrounded by a 93 ft diameter boulder and earth wall, 4-8-16 ft thick.

b. A secondary round house overlies the wall of the primary structure.

c. A later rectangular house occupies the site of the primary, and associated enclosure walls cross the outer yard wall, and the sites of primary and secondary round houses. Possibly mediaeval. A further rectangular foundation lies beyond to the east.

The original yard entrance lies centrally, west (R.C. Scott; F. Newall, DES 1957, 30. H.M. Sinclair; F. Newall, P.S.A.S. XCV, 1961-62, 161, Fig 7).

This appears to be "The Big Ring", the site of Renwick's conventicles on Duchal Moor between Ladymuir and Craigminnan (Murray - *Kilmacolm, A Parish History,* 1907, 89).

21. Hillside, Green Water, Kilmacolm, NS29256945 (25)

A circle, 41 ft over a 6 ft thick wall contains in the south east the ruins of an inner structure. Traces of outer walling lie 24 ft out on north and north west, indicating an enclosure of c 90 ft in diameter. Against a further stretch of walling on the north east is a square tumble, 10-12 ft across (W.O. Black; F. Newall, DES 1957, 31).

22. Devol Moor, East, Kilmacolm, NS327726 (24)

Heather covered mounds of concentric yard and house walls, each 10 ft wide, enclose respectively 72 ft and 30 ft diameters. On the moor to south and west are narrow fields separated by lines of single boulders (W.O. Black; F. Newall, DES 1957, 31).

23. Moyne, Neilston, NS47325344

At the north extremity of a promontory in the south west angle of Harelaw Dam, a 6 ft thick boulder faced rubble walled enclosure, 77 ft by 71 ft contains a central hollow, possibly the floor of a timber house (W. Lonie; F. Newall, DES 1963, 46).

24. Smeath Hill, Kilmacolm, NS315661 (26)

A central house, 27 ft in diameter within a 4 ft thick wall is separated from an outer boulder and edge-set slab kerbed wall, 8-11 ft thick, by a corridor which is subdivided into cells, three to the south, and three to the north of the house. Those on the north are entered through the outer wall on the west; those to the south by an entrance in the east which faces the house entrance, and also gives access to the north corridor. The overall diameter is 70 ft. (D. McKinnon; F. Newall, DES 1957, 29. H.M. Sinclair; F. Newall, P.S.A.S. XCV, 1961-62, 162, 165, Fig. 4).

25. Middlepenny, Erskine, NS38127289

A volcanic plug is encircled by stone walling at least 6 ft wide, and overall 110 ft in diameter. An entrance in the east-north-east is slightly indicated (W.O. Black; F. Newall, DES 1967, 45).

Among several mediaeval earthworks in the Paisley area, the following may be Iron Age homesteads.

26. Barshaw, NS499647 (Byres Hill)

A circular turf walled enclosure c 100 ft in diameter (O.S. 6", 1909-11, 1938, XII. NE).

27. Keir Hill, East of Arkleston Hill

N.S.A. 138 fn. "Vestiges of a British Fort" -- "a wall encircling a circle c 70 yards in diameter". Semple, 232. "In the lands of Rosshill (West of Cardonald) are vestiges of an old British Camp". The most likely site is the drumlin, now overbuilt at NS514642.

The following sites, apparently fortified but not clearly definable are possible Iron Age rather than post Roman, or are possibly originally Iron Age.

28. Midhill Plantation, Kilmacolm, NS355730 (Ainsley "Moat Hill")

At the south east corner of the plantation an indeterminate area surmounting a low rocky plateau is enclosed by a wall 10-12 ft thick, which can be traced along the west, south and south-west. (David Newall; Frank Newall, 1971).

29. Lochwinnoch Moors, NS31886098

A crag site with excavated hollow at the south end and traces of a mound round the south, part of the west and possibly round the north end. A possible homestead (A. Hallifax Crawford; F. Newall, 1959).

30. Gryffe Castle, Houston, NS385666

A Mediaeval motte and bailey crown a summit with traces of a low stone mound round the east end, and on the south east, round the foot of the hill, a broad earth mound. Possibly originally an Iron Age site (A. Hallifax Crawford; F. Newall; 1954).

31. Reive Hill, Eaglesham, NS53855035

A circular enclosure, 63 ft overall has indications along the west side of different foundation alignments. Mr. Gibb of Greenfield Farm said that the structure was rebuilt by his grandfather in 1870 for folding sheep, from an earlier ruin, and that it continued to fold sheep within good high walls until 1938 when it became a target for light artillery (A. Hallifax Crawford; F. Newall, DES 1958, 31).

32. Housecraigs, Mearns, NS568559

On the north-west margin of the summit of a volcanic plug,

a bank, 18m long by 5m thick, extended south-west by 20m of low bank on bed rock, and a further 11m forming a curve. A possible earthwork (T.C. Welsh, DES 1973, 45); if so, then possibly Iron Age.

33. Craig of Neilston, Neilston, NS475557

"Across the ridge c 50m from its south end a wall base 12m wide and at least 15m long is followed at 7m by a possible infilled ditch 6m wide. The area to the south is on two levels, bounded on the west and east by crags c 2m high. Skirting the edge of the site is a fragmentary wall, evidently of rubble between facings, up to 5m broad, enclosing a sub-rectangular area 28m x 23m. Extending 12m from the north wall around an entry in the north east angle, and overlying the putative ditch is a curved outwork 4.5 - 6m thick. Within the enclosure are traces of foundations 7.5m x 6.5m in the north west corner and 10m x 8m against the south wall. On the elevated level east side, near the south east corner is a nearly circular foundation 12m in diameter over 2m walls". (T.C. Welsh. DES 74, 54). Possibly an Iron Age foundation.

34. Comrigs, Eaglesham, NS563520

"At the north end of a prominent tabular ridge bounded by crags 5m high a marginal wall 2-3m thick can be traced forming an oval enclosure overall 24m east-west x 29m north-south. At the north end is a sub-circular foundation 5m in diameter over 1-1.5m walls". (T.C. Welsh, DES 74, 54). A possible Iron Age homestead.

Castlehill, Drumler Craigs (Christison, P.S.A.S., XXVII, 1892-93, 402 - "A name only". Erroneously included under Ayrshire). Slight traces of walling on the crest of the north slope, and of boulder alignment downslope are suggestive, but do not warrant conclusion without excavation (W. Lonie: F. Newall, 1963).

With the homesteads must be included the Clyde "crannogs" which are basically large timber houses within enclosed areas.

35. Langbank West. Erskine, NS381736

A central area possibly supported a subrectangular timber house platform. Flat floor timbers are visible and one upright post. The site was explored by boys from Langbank Primary School, in 1928, when the timbers exposed suggested to them the remains of a wooden ship; whereafter the site was termed locally "The Sunken Ship".

The floored area is surrounded by a low tumbled stone wall. Beyond this round the west side are two concentric arcs of upright posts. The overall dimensions are 99 ft east-west by 88 ft. The site is strictly analogous to No 36 below, and should date to the same period. (A. Hallifax Crawford; F. Newall).

36. Langbank East, Erskine, NS404733

The dimensions are similar to No 35. Within an enclosing stony bank is a central area c 50 ft in diameter, which is shown in the 1901-02 excavation plan to have been ringed with upright piles. Two peripheral beams were in position. An Iron Age brooch, and comb, referred to the second century A.D. were recovered.

(T.G.A.S., NS, V. Pt 1, 1905, 43-53: Scott, J.G., *South West Scotland,* 59-60, Fig 35. P.S.A.S., LXIII, 1928-29, 320).

Floor timbers are visible, and fragments of bone and shale may be recovered (A. Hallifax Crawford; F. Newall).

37. Erskine Ferry, Old Kilpatrick

Carbonised unthreshed ears of barley and many other seeds were recovered from the crannog or pile structure at Erskine Ferry, Old Kilpatrick, in 1906 (P.S.A.S. XLV, 1910-11, 164; LXVII, 1932-33, 71).

38. Dumbuck, Old Kilpatrick, NS423729

A similar house platform to those of Nos 35, 36, with an adjacent small mooring port with canoe. A genuine Iron Age crannog, despite the remarkable "finds". (P.S.A.S. XXXIV,1899-1900, 439-62).

An excellent plan is retained in the Hunterian Museum.

39. Castle Semple Loch, Lochwinnoch, NS359586

See under Canoes, below, for a possible crannog.

With these large timber houses and the smaller forts and concentric walled homesteads compare the "forts" at Bankhead, Darvel, NS573388, and Gourock Burn, NS215454, Ayrshire, both of Roman Iron Age. (T.A. Hendry, DES 1962, 23: 1963, 22; DES 1968, 13: 1969, 12; 1972, 14-15) With the small crag forts compare Aitnock, NS280511, and Castlehill, Hourat, NS287537, Ayrshire, both of which produced Roman finds. (P.S.A.S., LXVI, 1932,377-78).

HOUSES

Among the many large round houses are several which are analogous to Iron Age houses elsewhere. Apart from these it is

possible, as previously indicated, that the more isolated round house with associated fields is of the Iron Age rather than the Bronze Age.

1. Kelly Cut, Inverkip, NS227697

North of the Kelly Cut, aligned east-west with rounded north end recessed into the hill slope, and the south lip demarked by a curved earth and stone wall, a hut platform, 57 ft east-west by 47 ft. (W. Lonie; F. Newall, DES 1963, 44). Cf. Knock Hill, Largs, NS 202627 - Two large terraced house platforms. (Alastair S. Newall; W. Lonie; F. Newall, DES 1971, 13). Similar structures persist in the Post Roman Iron Age and later (see Leslie Rymer; Elizabeth B. Rennie - *Charcoal Hearths or Hut Platforms?* Cowal Arch. Soc. Trans., 1974, 5-7, 20-21).

2. Burnbank D. Kilmacolm, NS295684 (3D)

South west by 200-220 yards of Burnbank B (see the Bronze Age), a subrectangular house, 34 ft in diameter over 7 ft wide walls. A narrow 2 ft wide east entrance opens into a room 12 ft by 6 ft, from which a room 12 ft 4 ins by 11 ft 3 ins may be entered. These lie east of a 2 ft wide wall which cuts off the west segment of the house to form a narrow D-shaped rear chamber. (W.O. Black; F. Newall, DES 1959, 30. P.S.A.S. XCV, 1961-62, 162, Figs 3,4).

3. Blacketty Water East, A. Kilmacolm, NS307667 (5A)

Topping a rise, a subrectangular house, 23 feet over 5 ft wide walls, is subdivided internally and has a small sub-circular annexe attached on the north, 10 ft wide internally. (D. McKinnon; F. Newall, DES 1957, 28).

4. Blacketty Water East, B. Kilmacolm, NS307668 (5B)

A circular house, 25 ft in diameter over a 4 ft thick wall, subdivided internally, and with oval annexe 18 ft by 9 ft attached on the north. A hollow way bifurcates round this house. (D. McKinnon; F. Newall, DES 1957, 28; P.S.A.S., XCV, 1961-62, 162-3, Fig 4).

5. East Green, Kilmacolm, NS335684

Overlooking the ford below the confluence of the Green Water and Blacketty Water, partly recessed into the upper edge of the north bank, a stone lined and walled oval foundation, 33 ft by 30 ft over 4-6 ft wide walls. Possibly Late Iron Age but perhaps later. (W.O. Black, DES 1964, 46).

6. Loch Thom, Inverkip, NS25707252

A round house, 26 ft in diameter over 6 ft wide walls with 3 ft long porch projection of the walls on each side of the 4 ft wide south entrance. A later kiln is built into the interior. (W. Lonie; A.S. Newall; F. Newall, DES 1970, 44).

7. Windy Hill, Lochwinnoch, NS318638

On the surface of Windy Hill, a faint oval or circular foundation, 35 ft by at least 30 ft, walling being distinct only on the south. The defensive position renders it probably Iron Age. (A. Hallifax Crawford; F. Newall, DES 1969, 43).

8. Crossmyloof, Cathcart, c NS572623

"An underground galleried and alcoved house --- situated precisely on a line leading from the prehistoric circular defensive earthwork in Queen's Park to a similar though smaller earthwork in Pollok Wood". (Mann - *Mary Queen of Scots at Langside,* 100). The Queen's Park and Pollok Wood Sites are Mediaeval. (*Queen's Park* - H. Fairhurst; J.G. Scott, The Earthwork at Camphill, Glasgow. P.S.A.S., LXXXV, 1950-51; Pollok Wood, I.D. Shanks; E. Talbot, DES 1973, 27, where a second Mediaeval Ring Work on Pollok Estate is recorded).

9-10. Laggan Hill, Mearns, NS48605299

On the east flank of the hill, on a terrace under the lee of a scarp to the west, are two scooped hollows.

a. 26 ft 6 ins by 25 ft 6 ins over a 4 ft thick wall.

b. Oval, 22 ft by 17 ft walled round the west side only.

(W. Lonie; F. Newall, DES 1963, 47). Cf. Castle Hill, Largs, NS233604, where at least nine similar sunken hut bases are to be found. (P.S.A.S. XXVII, 1892-3, 402, No. 18; W. Lonie; F. Newall, DES 1964, 22), and Knock Hill, Largs, where several terraced hut hollows occupy the south-east flank of the hill (W. Lonie; A.S. Newall; F. Newall, DES 1971, 13).

CAVES

Calder River, Lochwinnoch.
Meikle Cloak Caves, NS34346068

The inner recess of an undercut rock, due to the backlash of flood waters beneath a waterfall rises to a higher level on the south bank where an inner chamber 4-5ft high may be reached through a horizontal crevice only 18 ins high. A short distance upstream is a larger cave. (David Beck; James and Albert Mackie, DES 1961, 44).

The latter cave is probably that referred to by Semple (Continuation of Crawford's *History of Renfrewshire,* 167) and Crawford (*The Cairn of Lochwynyoch* mss. XI, 209). Two querns found in the cave were lodged by a Mr. Montgomerie in the Hunterian Museum. The cave is traditionally a Covenanting and later refuge.

CANOES

Castle Semple Loch, Lochwinnoch

O.S.A. XV, 97, 1795. "Several canoes were lately found in the loch about 5 ft below the surface, each of a single tree". Crawford, *Cairn of Lochwynyoch* mss. XI, 206, 1827-37, "A living witness saw 21 canoes buried in the bed of the loch --- between the peel (i.e. Peel Castle) and this side (i.e. the Johnshill side) of the loch".

N.S.A., 1842, 97. "Twenty one canoes were found buried in mud between the peel and the north side of the loch. A canoe is preserved in the garden of Allan Pinkerton of Mossend. Stuart (P.S.A.S. VI, 1864-66) suggests with probability that what was seen in the mud of the loch was the remains of a crannog.

In 1960 a half canoe, found in 1952, was given a rough dating in the Late Iron Age, following pollen analysis.

Kilmalig Chapel, Erskine, NS36557297

Gibb, *Much About Kilmacolm,* 1872, 49. "A canoe hollowed out of a tree of considerable length and breadth was found a few years prior to 1872 at a place near the smithy of Finlayston, called Chapelhill or Kilmalig". The site of the chapel is discernible.

SMALL FINDS

Beads

Lochwinnoch Parish?

Three vitreous paste beads and a small naturally perforated flint disc were formerly used collectively as a cure for adder bite in Lochwinnoch (Possibly by the family of Craig of Auchenhame). The beads were: a. An irregular globule of yellow paste. b. Clear blue glass with an irregular band of white enamel round the circumference. c. Dark coloured paste with small dots of red and white. (P.S.A.S. XXVII, 1892-93, 471-2).

Stone Ball

Broadfield Farm, Lochwinnoch, c NS405585
A carved stone ball. (Paisley Museum).

Stone Ladles

Titwood House, NS57156326
From the site of Titwood House, between Newark Drive and Nithsdale Road, Pollockshields. "A handled cup like a ladle of sandstone". (Mann - *Mary Queen of Scots at Langside*, 9).

Holehouse, Neilston, NS469568
A stone ladle with the handle broken off. (Pride, *History of Neilston*, 101, Plate facing).

Shale Rings

Lawpark, Kilmacolm, NS344679
A fragment of black shale bracelet 0.3 ins wide with a flat inner surface, and 2.3 ins in internal diameter. A fragment of black shale broken across a large perforation, probably from a large flat shale ring.

Part of a black shale disc with knife marked central perforation. (D. McKinnon; F. Newall, 1961).

The last may be Mediaeval. A similar knife-perforated shale disc was recovered with Mediaeval sherds by Ian Grant, President of the Society, near early house foundations at Caldwell Law Cf. Gryfe Reservoir, Mediaeval shale bracelet (*The Western Naturalist*, 1, 1972, 51, Fig. 3: 53).

Footnotes

1. P.S.A.S. XXXIII, 1888-89, 13-33; XXVII, 1892-93, 19-20.

2. Within the east rampart a socket is capped by a fused semi-circle of sandstone fragments. (W. Lonie; F. Newall, 1966).

3. P.S.A.S. LXIX, 1934-35, 77; LXXII, 1937-38, 44-55.

4. T.B.N.H.S. XVI. 1964. To set the record straight it must be observed that, a. The major part of the axe mould was built into the secondary wall. b. There is no question of the primary "wall" having tumbled downslope. This was carefully considered during our excavations. c. The occupation debris within the stockade post holes could only have slipped in during removal of the posts. In short, the second phase followed closely on the first.

5. MacKie, Euan. *English Migrants and Scottish Brochs*. G.A.J., 2, 1971, 44-71.

6. T.G.A.S.: NS, V. Pt 1, 1905, 43-53. A decorated comb is illustrated; Scott, J.G., *South West Scotland,* 60, Fig 35b.

7. Scott, J.G., *South West Scotland,* 56, Fig. 33.

8. P.S.A.S. XV, 1880-81, 158-78.

9. Dr. Anne Ross, *A Pagan Celtic Tricephalos from Netherton, Lanarkshire.* G.A.J., 3. 1974, 26-33.

Addendum

40. A fifth Clyde crannog lies on the foreshore north of Erskine Mansion House, NS24587288. The site was visited with Mr. Ian Grant, Mr. John Macdonald and Mr. Calum Morrison. The site is remarkable for the size of the timbers used in a double enclosing palisade, comprising uprights in excess of 9 inches in diameter, and in the heavy timber flooring which incorporates half round timbers greater than 12 inches across. Overall about 90 feet in diameter.

On the foreshore further east a canoe was located in March, 1977.

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A CONTRIBUTION TO THE BRYOPHYTE FLORA OF AILSA CRAIG

By DAVID G. LONG
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Unlike the vascular plants of the island (see Mitchell 1972 for bibliography) bryophytes have received very little attention in the past. Balfour (1845) and Vevers (1936) appear to provide the only published lists, and these resulted from somewhat cursory collections made in the course of other studies. Balfour enumerated eighteen species and varieties; Vevers added a further thirty-six. The only recent published record (Crundwell 1973) is of *Philonotis rigida* collected by D.A. Ratcliffe in 1972. The presence of this Mediterranean species, and also Vevers' record of the oceanic *Frullania germana*, indicated that other southern or western bryophytes might be present.

Through the kindness of Mr. J. Mitchell of the Nature Conservancy Council I was able to spend a day studying bryophytes on Ailsa Craig in May 1977 for the purpose of drawing up the present list, which has increased the total flora to 123 taxa. Of the old records only sixteen were not confirmed. Limited time precluded full exploration of the island hence efforts were concentrated on what appeared the most promising ground, the 'Swine Holes' on the north side of the island, consisting of sheltered gullies, wet rocks, caves and moist peaty slopes in places with good growth of *Sphagnum*. Probably because of the shelter and higher humidity of these slopes a surprisingly large number of species was recorded. Study was also made of the disturbed ground, buildings, walls and grassy slopes on the flat eastern part of the island around the lighthouse, and also of the drier rocky slopes and screes between the lighthouse and the Swine Holes.

The following list includes all taxa at present recorded on the island. Nomenclature follows Warburg (1963) for mosses and Paton (1965) for liverworts. The records of Balfour and Vevers are mostly unlocalised and are designated by 'B' and 'V' respectively. Balfour's list was incorporated into Vevers' list without indication of how many species had been refound. Records from the present study are localised into three areas: 1. lighthouse area; 2. lower slopes between lighthouse and Swine Holes; 3. Swine Holes. Notes on habitat are included. The symbol # indicates those old records which still require confirmation. An asterisk* denotes species not previously recorded

from Ayrshire. Voucher specimens of the rarer species have been deposited in the herbarium of the Royal Botanic Garden, Edinburgh.

Mosses

	Acrocladium cuspidatum		1	damp turf
#	*A. stramineum*	BV		
	Amblystegium serpens		1	wall
#	*Antitrichia curtipendula*	BV		
#	*Atrichum undulatum*	V		
	Aulacomnium androgynum		2	in burrow
#	*A. palustre*	BV		
	Barbula convoluta		1	footpath
	B. cylindrica		1	wall
	B. fallax	BV	1	footpath
	B. hornschuchiana		1	footpath
	B. rigidula		1	boulder
	B. tophacea		3	wet rock face
	B. unguiculata		1	waste ground
	Bartramia pomiformis		2	in burrow
	Brachythecium albicans		1	waste ground
	B. rivulare		3	damp stones in stream
	B. rutabulum	V	3	slopes of gully
	Bryum alpinum	BV	2,3	damp hollows on footpath
	B. argenteum	BV	1	footpath
	B. bicolor	V	1	footpath
	B. capillare	BV	3	rocks
	B. pallens		3	wet stones in gully
	B. pseudotriquetrum		3	marshy ground
*	*B. sauteri*		3	soil on bank of gully
	Camptothecium sericeum	BV	3	wall
	Campylopus flexuosus		2	peaty slope
	C. introflexus		1	peaty waste ground
	C. pyriformis	V	2	peaty slope
	Ceratodon purpureus	V	1	waste ground
	Cratoneuron filicinum		3	moist shaded rocks
	Cynodontium bruntonii		3	on dyke in gully
	Dichodontium pellucidum		3	stones in stream
#	*Dicranoweisia cirrata*	V		
	Dicranum scoparium	BV	2	block scree
	Drepanocladus aduncus		2	wet rocks
#	*D. fluitans*	V		
	Eurhynchium praelongum	V	2	amongst scree blocks
	E. striatum		3	bank of gully
	E. swartzii		3	bank of gully
	Fissidens bryoides		3	shaded soil in gully
	Funaria hygrometrica		3	footpath

Grimmia maritima		3	on dyke in gully
# *G. trichophylla*	V		
Heterocladium heteropterum var *heteropterum*		3	wet rock face
Hypnum cupressiforme var *cupressiforme*	BV	3	on rocks
var *ericetorum*	V	2	grassy slopes
var *resupinatum*	V	3	boulders and dry rocks
var *tectorum*		1	in turf
Isopterygium elegans		3	bank of gully
Isothecium myosuroides	V	3	rocks
# *I. myurum*	V		
Mnium cuspidatum		1	in turf
M. hornum	V	3	peaty banks
M. punctatum		3	stones in stream
M. undulatum	V	3	soil in gully
Orthotrichum anomalum		1	on concrete slab
O. diaphanum		1,3	walls
Philonotis fontana	BV	3	mud by stream
P. rigida (see Crundwell 1973)			
Plagiothecium succulentum		3	bank of gully
P. undulatum	V	3	bank of gully
Pleurozium schreberi		1	in turf
Pohlia delicatula		3	damp soil in gully
P. nutans		3	peaty slope
P. wahlenbergii		3	damp soil by stream
Polytrichum aloides		3	soil on bank of gully
# *P. alpestre*	V		
# *P. commune*	V		
P. juniperinum	V	1	peaty waste ground
P. piliferum		2	dry peaty slope
* *Pottia crinita* var *crinita*		3	rocky ground by footpath
Pseudoscleropodium purum		1	in turf
# *Pterogonium gracile*	BV		
Rhacomitrium aciculare		3	brickwork in stream
R. lanuginosum	BV	2	on scree
Rhynchostegiella tenella		3	damp shaded rock face
Rhytidiadelphus squarrosus	V	1	in turf
# *R. triquetrus*	BV		
* *Scleropodium tourettii*		1	in turf
Sphagnum capillaceum		3	peaty bank
# *S. cuspidatum*	V		
S. fimbriatum	V	3	peaty bank
S. palustre	V	3	peaty bank
S. recurvum		3	peaty bank
Thamnium alopecurum	V	3	wet rocks in gully
Tortula muralis	V	1	wall
Trichostomum brachydontium		3	bank of gully

Weissia controversa		3	on dyke in gully
Zygodon viridissimus var *viridissimus*		1,3	walls

Liverworts

Barbilophozia floerkii		2,3	peaty banks
Calypogeia arguta		3	soil on bank of gully
C. muellerana		3	bank of gully
Cephalozia media		3	wet peaty bank
* *Cephaloziella starkei*		2	peaty bank
Chiloscyphus polyanthos	V	3	wet stones in gully
Conocephalum conicum	V	3	moist rock face in gully
Diplophyllum albicans		3	rocky bank of gully
Frullania dilata	BV	2	dry rock face
F. fragilifolia		2	dry rock face
F. germana	V	3	rocks in gully
F. tamarisci	BV	3	boulder by footpath
* *Lejeunea lamacerina* var *azorica*		3	wet rock face in gully
L. patens		3	damp turf in gully
L. ulicina		3	shaded rock face in gully
Lepidozia reptans		3	peaty banks
# *Lophocolea bidentata*	V		
L. cuspidata		3	peaty bank
Lophozia ventricosa	BV	2,3	peaty banks
Metzgeria furcata		3	shaded rock face
Nardia scalaris		3	peaty banks
# *Pellia epiphylla*	V		
P. neesiana		3	wet rocks in stream
Plagiochila asplenioides var *asplenioides*		3	rocky bank of gully
Porella cordaeana		3	rocks at cave mouth
# *Reboulia hemisphaerica*	BV		
Riccardia pinguis		1	damp hollow on turf
Saccogyna viticulosa		3	wet banks in gully
Scapania compacta		3	rocky bank
S. gracilis		3	rocks in gully
S. undulata	V	3	stones in stream
Solenostoma crenulatum		3	soil on bank of gully

Total: 123 taxa (91 mosses, 32 liverworts)

Deletions from list:

Hypnum cupressiforme var *minus*	V	not now recognised as a distinct taxon.

Philonotis caespitosa	V	A critical species; must be regarded as very doubtful in the absence of a specimen.
Plagiothecium denticulatum	V	Old records of this are ambiguous; it could refer to *P. succulentum*.

The majority of bryophytes found on Ailsa Craig are widespread in southern Scotland, but the occurrence of such a large number of species for a small island is due to the diversity, often on a very small scale, of edaphic and climatic conditions. For example the moist peaty slopes, though of limited extent, are sufficient to support a typical flora including four *Sphagnum* species and hepatics such as *Cephalozia media*, *Lepidozia reptans* and *Lophozia ventricosa*. The drier peaty slopes support a different flora with *Polytrichum* and *Campylopus*. Rocks are predominantly acidic but again their colonists vary according to degree of shelter and humidity. Basic rocks are found only where the dykes outcrop and predictably support several basiphiles, e.g. *Cynodontium bruntonii* and *Weissia controversa*. Additional diversity is provided by the disturbed and man-made habitats around the lighthouse.

The most interesting bryophytes found on the island are three 'Mediterranean' mosses, *Philonotis rigida*, *Pottia crinita* and *Scleropodium tourettii*. In Britain these have a markedly southern distribution. *Pottia crinita* extends further north than the others which are at the northern limit of their range here and are known from very few other Scottish localities. Predictably a number of oceanic hepatics are found on the island, mostly in the sheltered gullies of the Swine Holes. These are *Frullania germana*, *F. fragilifolia*, *Lejeunea lamacerina* var *azorica*, *L. patens*, *L. ulicina* and *Saccogyna viticulosa*.

In conclusion, it is clear that Ailsa Craig has a rich bryophyte flora considering its small size, exposed situation and uniform geology. Further study will certainly reveal other species and hopefully lead to refinding of some of the taxa not seen in 1977. Particularly desirable is confirmation of the record of *Antitrichia curtipendula* a species rare in southern Scotland and which has been greatly decreasing its range in lowland Britain in recent years.

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SPIDERS AND PHALANGIDS OF INCHCAILLOCH, LOCH LOMOND
III - COMPARISON WITH THE MAINLAND

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Introduction

The Loch Lomond National Nature Reserve comprises Inchcailloch, with other islands, and a mainland portion. The mainland part of the Reserve, approached from Gartocharn, lies beside the River Endrick which flows into the south-east corner of Loch Lomond (Fig. 1). Aspects of the arachnid communities of Inchcailloch have been considered earlier (Curtis, 1973, 1975, 1978) and this paper compares the island fauna with that of the mainland.

The island of Inchcailloch is covered mainly with deciduous woodland, primarily of oak (*Quercus* spp.), with areas of mixed woodland including birch, hazel and other species. Alder carr occurs in low-lying areas, some Scots pine stands on the higher ridge, with a few clear areas. More details of the island vegetation are available (Horrill, Sykes and Idle, 1975), but in broad terms the dominant biotope is deciduous woodland. In contrast the mainland part of the Reserve includes areas of markedly different character. Deciduous woods with tree species and ground flora similar to those of Inchcailloch are present in the Entrance, Shore, Pentagonal and Ring Woods. Within the Ring Wood East is a distinct area of birch woodland with well-developed moss lawns and hummocks involving *Sphagnum* and *Polytrichum* species. Areas of open grassland are the Limehill Field, Limehill Rough, Pentagonal Field and Ring Point, with boggy areas such as the Whin Park (wet/dry heath mosaic), Ring Bog, Aber Bog, the Twenty Acres and, to the north-east of the River Endrick, Crom Mhin. The relative areas of these wooded and open habitats are apparent in the sketch map (Fig. 1).

The spider and phalangid communities have been studied since 1971 and the data on which this comparison is based are derived mainly from the following work: Inchcailloch, 1971-73: four sites sampled by Dr. Curtis; mainland, 1974-76: seven sites sampled by Dr. Curtis; Inchcailloch and mainland, 1974-75: four sites sampled by Mr. Langley; island and mainland, 1976-77; three sites, Dr. Curtis and Mr. Stewart; island, 1977-78: 16 sites, Dr. Curtis and Mr. Thompson; mainland, 1977-78: 15 sites sampled by Mr. Bowditch; Crom Mhin, 1977: one site, Dr.

Figure 1: Sketch map of the Loch Lomond National Nature Reserve. Cross-hatching indicates the woodlands of the Reserve, with different angle of lines in the moss-rich Ring Wood East. Stipples indicate open areas of the Reserve.

EW - Entrance Wood; PW - Pentagonal Wood; RW - Ring Wood; SW - Shore Wood; RB - Ring Bog; RP - Ring Point.

Curtis. Additional data have come from work by Mr. P. Lerpiniere and also by Mr. E. Morton (Curtis and Morton, 1974). These studies have concentrated on the ground-active fauna, using pitfall traps of various types. Complementary sampling with corrugated paper traps on tree trunks, sweep netting, vacuum extraction and hand sorting have added a few species from other vegetation strata. These species from higher vegetation are usually taken, albeit in small numbers, in pitfall traps when a prolonged sampling programme is employed.

Species Complements

Twelve species of harvestmen (Phalangida) and 184 species of spiders have been recorded from the Reserve. While the phalangids are relatively ubiquitous over both island and mainland, the spiders show more variation in distribution. The occurrence of the 196 species in four categories is listed in Table 1, which uses the nomenclature of Locket, Millidge and Merrett (1974) (below referred to as LMM) for spiders. The four categories used are (1) the woodland of Inchcailloch, (2) "grassy" woodlands of the mainland which have ground floras similar to those of Inchcailloch, (3) "mossy" woodlands of the Ring Wood East, and (4) open habitats of the mainland.

Spider species include 27 confined to Inchcailloch, seven restricted to grassy mainland woods, 13 to the mossy Ring Wood East and 16 to the open areas of the mainland. The total species richness of the spider faunas of the four areas are respectively 129,102,108 and 83 species. This would appear to indicate greater richness for the island, or a more diverse fauna, but a critical examination of the data does not confirm this. Considering a single year of sampling, 1976-77, when the woodlands were sampled concurrently using the same method (pitfall traps with formalin/teepol trapping fluid), we find richness values of 66, 71 and 59 species for Inchcailloch, mainland grassy and mossy woods respectively. The numbers of individuals corresponding to the last three species richness values are 1833,1234 and 777, indicating a more active and/or dense population on Inchcailloch.

One can calculate the estimated number of species for a given sample size. Thus, for a collection of 100 specimens per site over the year, one would expect 14 species from Inchcailloch, 33 from the grassy wood and 28 from the mossy wood on the mainland. Resolution of these apparently conflicting data lies in the relative abundances of the various species in the communities. These are illustrated in Fig. 2, where it can be seen that the Inchcailloch community contains a large number of rare species, each represented by a single specimen, whereas the grassy wood of the mainland, and to a lesser extent the mossy site, has many species which are

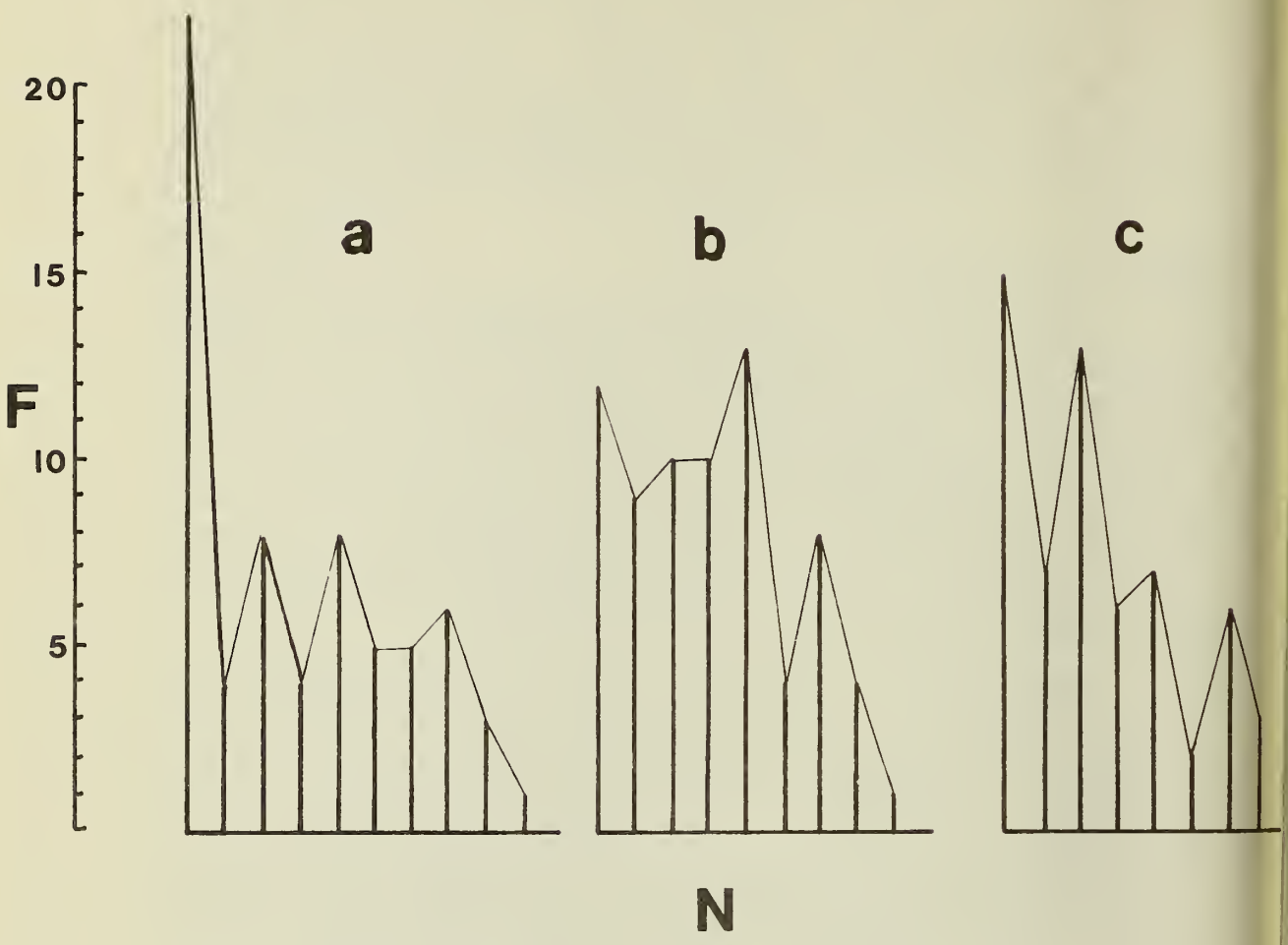

Figure 2: Species-frequency diagrams for the three woodland areas: a - Inchcailloch, b - grassy mainland (Ring Wood East), c - mossy mainland (Ring Wood East). Bars represent the frequency (F) of species represented by N individuals, with N starting at unity and doubling at each step, i.e. 1,2,4,8,16,32,64,128,256 and 512. The most obvious feature is the relatively high frequency of rare species on Inchcailloch.

moderately abundant. Accordingly, for a standard sample size (or sample period) one expects more species from the mainland woods than from the island.

Community Comparisons

Irrespective of relative abundances, the spider data show no significant similarity, nor dissimilarity, between Inchcailloch and the combined mainland woods ($X^2 = 0.46$, d.f. = 1, p = 0.5 approx.). However, in spite of a strong likeness between the two types of woodland on the mainland ($X^2 = 18.87$; $p<0.001$), the spider fauna of the grassy mainland woods is similar to that of Inchcailloch ($X^2 = 11.25$; $p<0.001$). The fauna of the open areas of the Reserve shows no strong similarity to any of the woodlands.

Cursorial Hunters

In broad terms, phalangids are the dominant cursorial hunters on Inchcailloch and lycosids (wolf spiders) on the mainland. The phalangids *N. bimaculatum*, *M. morio*, *O. tridens*, *O. palpinalis* and *L. ephippiatus* are all more active in the woods of the island than those of the mainland and, with the exception of *M. morio*, even less prominent in open land. *O. agrestis* and *O. hanseni* are more active in mainland woods.

Effectively replacing these harvestmen on the mainland are the lycosids: *P. pullata*, *P. amentata*, *A. pulverulenta*, *T. spinipalpis* and *P. hygrophilus*. Only the wolf spider *P. lugubris* is more active on Inchcailloch than in the Gartocharn woods. Tetragnathid spiders in the genus *Pachygnatha*, like lycosids, spin no webs when adult, and show a contrast between *P. clercki* which is more active in open and wooded mainland than on Inchcailloch and the converse pattern for *P. listeri*.

Web Spinners

The theridiid and linyphiid spiders spin more or less horizontal sheet webs with varying amounts of vertical threads attached and also show contrasts between the different areas, though not as marked as the cursorial hunters. The theridiid, *R. lividus*, is more active on Inchcailloch than in the mainland woods and is relatively infrequent in the open areas.

Relatively abundant linyphiid species which are more numerous on Inchcailloch include *W. acuminata*, *D. tibiale*, *D. picinus*, *H. excisa*, *C. sylvaticus*, *M. rufus*, *L. zimmermanni*, *L. tenebricola* and especially *M. fuscipes*. *G. rubellum* is found only on Inchcailloch and appears to be replaced by its congener *G. rubens* on the mainland. *D. latifrons* is more abundant in the mainland woods

than in either open areas or on Inchcailloch, while other species with mainland predominance tend to be most abundant in mossy woodland or open areas: *C. obscurus*, *T. pallens* and especially *E. dentipalpis*.

These comparisons are based on data over the years, and one must realise that in addition to seasonal variations there can be marked fluctuations from year to year. This has been noticed for species such as *N. bimaculatum*, *O. tridens*, *O. palpinalis*, *W. acuminata*, *G. rubellum* and *C. dilutus*.

Rare Species

The term 'rare' may be applied to (a) species which are of infrequent occurrence over the country as a whole, and (b) those which were recorded infrequently on the Reserve but are more common elsewhere. The latter situation is most readily construed as a population which may be ephemeral and not likely to persist. However, this may not be the case as such infrequent species may be captured again after several years, indicating a permanent population which is relatively sparse or inactive and thus unlikely to be recorded in large numbers in pitfall traps. An outstanding example is *W. incisa*, which is rare in sense (a) being known elsewhere from a few scattered localities in England and Wales (LMM, pp. 126,200). A single male was taken on the North Hill of Inchcailloch in 1972 and another in 1977, again on the North Hill. *S. cornigera* is another example, with a few males being captured at sporadic intervals on Inchcailloch.

Other rare (sense (a)) species are indicated in Table I and interesting examples of these are:- *T. spinipalpis* which occurs in large numbers in the mossy places of the Ring Wood East; *M. subopaca*: Inchcailloch, only Scottish record, known from south-east England and a Liverpool factory (LMM, pp. 122,147); *B. pratensis*: in boggy areas of mainland, first Scottish record; *M. subaequalis*: mossy wood (LMM, pp. 128,246); *E. ignobilis*: mossy wood, first Scottish record (LMM, p.460); *A. crassiceps*: Ring Wood and Crom Mhin (LMM, p.250); *C. distincta*: Crom Mhin, few Scottish records (LMM, p.252); *M. sublestus*, Ring Wood East, elsewhere only Wicken and Woodwalton Fens, East Anglia, and Dubh Lochan, Stirlingshire (LMM, p.265); *L. pinicola*: Ring Bog, scattered distribution (LMM, p.280); *L. angulatus*: North Hill, Inchcailloch and mossy Ring Wood East, a northern species (LMM, p.280); *A. warburtoni*: mainland Reserve, only other Scottish record is at Loch Insh, Inverness-shire (LMM, pp.131,284).

The spider faunas of these habitats include many species otherwise not recorded from the counties of Dunbartonshire and Stirlingshire (indicated by Curtis, 1976). The woodland arachnofaunas of the Reserve are matched in importance by those of the

wetter open areas of the mainland; the Crom Mhin community ranks fairly well in comparison with other wetland locations in Strathclyde (Curtis, 1977).

Niches and Species

Why should there be so many rare (sense (b)) species on the island of Inchcailloch?

(1) The number of species in a community depends on the range of resources available for different species, and this is related to habitat diversity, or alternatively to 'niche availability'. The island appears to support a spider/phalangid community with higher numbers of individuals and of infrequent species than the mainland woods, which at first sight appear to offer as much variation in microhabitats. The environment on Inchcailloch certainly is heterogeneous; Horrill, Sykes and Idle (1975) have distinguished ten vegetation types and indicate that the mosaic of these types is on a relatively small scale. Thus one could argue that given the relative heterogeneity of environmental conditions, many species with slightly different ecological requirements are able to coexist. This may be affected by the relatively greater area of continuous woodland on Inchcailloch compared with the mainland woods, which could be regarded as 'habitat islands'.

(2) An alternative to the range of diverse habitats or possible niches is that the species present have narrow niches, or specialise in small ranges of environmental parameters. Consequently more of them can coexist. An important difference between the island and mainland could be the relative ease of access for spiders, although it is difficult to assess the effectiveness of the narrow water barrier between the island and the mainland. Nevertheless, it is possible that spiders may move more easily into the woodlands of the mainland because of the land links of these woods with others. This could explain the higher species diversity of the Gartocharn woods and possibly also the species frequencies.

Because of the higher probability of immigration into the mainland woods, the species there are likely to be 'better' competitors than their counterparts on Inchcailloch, in order to survive rather than be replaced by immigrants. Accordingly they tend to occur in larger numbers, perhaps utilising a wider range of resources. Thus the range of resources may be roughly equal in island and mainland woods, but because of differing degrees of competition the species of the mainland have broader niches.

Either explanation (1) or (2) could be appropriate. One could even argue the opposite of (2): spiders cannot escape

readily from Inchcailloch and so they are forced into a more competitive situation which is eased by narrower niches, leading to higher proportions of rare species. These concepts hint at the complex relationships which exist between the species and suggest intriguing lines of study of these communities.

Acknowledgements

The assistance and cooperation of the Nature Conservancy Council throughout these studies is gratefully appreciated.

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TABLE 1: Spiders and phalangids of Inchcailloch and mainland of Loch Lomond N.N.R.

Markedly different abundances are indicated by additional +.
R indicates species relatively infrequent or rare in Britain

Species		Part of Reserve			
		Inchcailloch	Mainland		
			grassy wood	mossy wood	open
AMAUROBIIDAE:					
Amaurobius fenestralis Stroem)		+	+	-	-
A. similis (Blackwall)		+	-	-	-
DICTYNIDAE:					
Dictyna arundinacea (Linnaeus)		-	-	-	+
OONOPIDAE:					
Oonops pulcher Templeton		-	+	-	-
DYSDERIDAE:					
Harpactea hombergi (Scopoli)		+	-	-	-
Segestria senoculata (L.)		+	-	-	-
GNAPHOSIDAE:					
Drassodes lapidosus (Walckenaer)	R	-	+	+	-
D. pubescens (Thorell)	R	+	-	-	-
Micaria subopaca Westring	R	+	-	-	-

TABLE 1 cont'd		Part of Reserve			
Species		Inchcailloch	Mainland grassy wood	Mainland mossy wood	Mainland open
CLUBIONIDAE					
Clubiona stagnatilis Kulczynski		-	-	+	-
C. reclusa O.P.-Cambridge		+	+	-	-
C. lutescens Westring		+	+	+	-
C. compta C.L.Koch		+	+	-	-
Agroeca proxima (O.P.-C.)		+	-	+	-
ZORIDAE					
Zora spinimana (Sundevall)		-	+	++	-
ANYPHAENIDAE					
Anyphaena accentuata (Walck.)		+	-	-	-
THOMISIDAE					
Xysticus cristatus (Clerck)		-	-	-	+
Oxyptila trux (Bl.)		+	+	+	-
Philodromus aureolus (Cl.)		-	-	-	+
P. rufus Walck.	R	-	-	+	-
SALTICIDAE					
Neon reticulatus (Bl.)		-	-	+	-
LYCOSIDAE					
Pardosa agricola (Th.)	R	-	-	+	++
P. monticola (Cl.)		-	-	-	+
P. palustris (L.)		-	-	-	+
P. pullata (Cl.)		+	+	++	+

TABLE 1 cont'd Species		Part of Reserve			
		Inchcailloch	Mainland grassy wood	Mainland mossy wood	Mainland open
P. prativaga (L. Koch)		-	-	+	-
P. amentata (Cl.)		+	+	++	+
P. nigriceps (Th.)		-	-	-	+
P. lugubris (Walck.)		++	+	+	-
Alopecosa pulverulenta (Cl.)		+	+	++	+
Trochosa ruricola (De Geer)		-	+	-	-
T. terricola Th.		+	+	+	+
T. spinipalpis (F.O.P.-C.)	R	+	+	++	-
Pirata piraticus (Cl.)		-	-	+	++
P. hygrophilus Th.		+	++	++	+
AGELENIDAE					
Cryphoeca silvicola (C.L.K.)		+	+	+	-
Antistea elegans (Bl.)		-	+	+	+
Hahnia montana (Bl.)		+	+	-	+
H. helveola Simon		+	-	-	+
THERIDIIDAE					
Anelosimus vittatus (C.L.K.)	R	+	+	-	-
Theridion pallens Bl.		+	-	+	-
Enoplognatha ovata (Cl.)		-	+	-	-
Robertus lividus (Bl.)		++	++	+	-
R. arundineti (O.P.-C.)	R	+	-	+	-
Pholcomma gibbum (Westring)		+	-	-	-

TABLE 1 cont'd Species		Part of Reserve			
		Inchcailloch	Mainland grassy wood	Mainland mossy wood	Mainland open
Theonoe minutissima (O.P.-C.)	R	+	-	-	-
TETRAGNATHIDAE					
Tetragnatha extensa (L.)		+	-	+	-
T. pinicola L.Koch	R	-	-	+	-
T. montana Simon		+	-	+	+
T. obtusa C.L.K.	R	+	-	-	-
Pachygnatha clercki Sund.		+	++	++	+
P. listeri Sund.		++	+	+	-
P. degeeri Sund.		+	+	+	+
Meta segmentata (Cl.)		+	+	+	+
M. mengei (Bl.)		+	-	+	-
M. merianae (Scopoli)		+	-	-	-
ARANEIDAE					
Araneus diadematus Clerck		+	+	+	-
A. quadratus Cl.		-	-	+	+
A. cornutus Cl.		-	-	-	+
A. umbraticus Cl.		+	-	+	-
A. cucurbitinus Cl.		+	-	-	-
LINYPHIIDAE					
Ceratinella brevipes (Westring)		+	+	+	+
C. brevis (Wider)		+	-	+	-
Walckenaera acuminata Bl.		++	++	+	+
W. antica (Wider)		-	-	+	-

TABLE 1 cont'd Species		Part of Reserve			
		Inchcailloch	Mainland grassy wood	Mainland mossy wood	Mainland open
W. cucullata (C.L.K.)		+	-	+	-
W. nodosa O.P.-C.	R	-	+	+	-
W. melanocephala O.P.-C.	R	-	-	+	-
W. incisa (O.P.-C.)	R	+	-	-	-
W. dysderoides (Wider)	R	+	-	-	-
W. nudipalpis (Westring)		+	+	+	-
W. cuspidata Bl.		+	-	-	-
W. vigilax (Bl.)	R	+	+	+	-
Dicymbium nigrum (Bl.)	R	+	+	+	+
D. brevisetosum Locket		+	+	-	++
D. tibiale (Bl.)		++	++	+	+
Entelecra flavipes (Bl.)	R	-	-	+	-
Moebelia penicillata (Westring)	R	-	+	-	-
Gnathonarium dentatum (Wider)		-	-	-	+
Gongylidium rufipes (Sund.)		+	-	-	-
Dismodicus elevatus (C.L.K.)	R	+	-	-	-
Hypomma bituberculatum (Wider)		+	-	-	+
H. cornutum (Bl.)		+	+	+	-
Metopobactrus prominulus (O.P.-C.)		-	-	-	+

TABLE 1 cont'd Species	Part of Reserve			
	Inchcailloch	Mainland		
		grassy wood	mossy wood	open
Baryphyma pratensis (Bl.)	R –	–	–	+
Gonatium rubens (Bl.)	+	+	++	–
G. rubellum (Bl.)	+	–	–	–
Maso sundevalli (Westr.)	+	+	+	–
Pocadicnemis pumila (Bl.)	+	++	++	–
Oedothorax gibbosus (Bl.)	–	+	+	+
Oe. tuberosus (Bl.)	–	–	+	–
Oe. fuscus (Bl.)	–	–	–	+
Oe. retusus (Westr.)	–	+	+	+
Oe. apicatus (Bl.)	+	–	–	+
Pelecopsis parallela (Wider)	–	+	+	–
P. mediocris (Kulczynski)	+	–	+	+
Silometopus elegans (O.P.-C.)	–	–	–	+
Cnephalocotes obscurus (Bl.)	+	–	++	–
Tiso vagans (Bl.)	+	+	–	+
Minyriolus pusillus (Wider)	–	+	+	–
Tapinocyba pallens (O.P.-C.)	+	++	++	–
Thyreosthenius parasiticus (Westr.)	+	–	–	–
Monocephalus fuscipes (Bl.)	+++	++	+	–

TABLE 1 cont'd Species	Part of Reserve				
	Inchcailloch		Mainland		
			grassy wood	mossy wood	open
M. castaneipes (Simon)	R	+	-	-	-
Lophomma punctatum (Bl.)		+	+	+	+
Jacksonella falconeri (Jackson)	R	+	-	-	-
Gongylidiellum vivum (O.P.-C.)		+	+	+	+
Micrargus herbigradus (Bl.)		+	+	+	+
M. subaequalis (Westr.)	R	-	-	+	-
Erigonella hiemalis (Bl.)		+	++	-	+
E. ignobilis (O.P.-C.)	R	-	-	+	-
Savignya frontata (Bl.)		+	+	+	+
Diplocephalus cristatus (Bl.)		+	+	-	+
D. permixtus (O.P.-C.)		+	+	+	++
D. latifrons (O.P.-C.)		++	+++	+	+
D. picinus (Bl.)		++	++	+	+
Araeoncus humilis (Bl.)	R	-	-	-	+
A. crassiceps (Westr.)	R	-	+	+	+
Caledonia evansi (O.P.-C.)		+	-	-	-
Erigone dentipalpis (Wider)		+	+	-	++
E. atra (Bl.)		+	+	+	+
E. arctica (White)	R	-	-	-	+

TABLE 1 cont'd Species		Part of Reserve			
		Inchcailloch	Mainland grassy wood	Mainland mossy wood	Mainland open
Leptorhoptrum robustum (Westr.)		+	+	-	+
Drepanotylus uncatus (O.P.-C.)	R	-	-	+	+
Hilaira excisa (O.P.-C.)	R	+	+	-	+
Porrhomma pygmaeum (Bl.)		+	+	+	+
P. pallidum Jackson		+	+	-	+
P. montanum Jackson	R	+	+	-	-
Agyneta subtilis (O.P.-C.)		+	+	-	-
A. conigera (O.P.-C.)		+	-	-	+
A. ramosa Jackson	R	+	-	-	-
Meioneta rurestris (C.L.K.)		-	-	-	+
M. saxatilis (Bl.)		-	+	-	-
M. beata (O.P.-C.)		-	+	-	-
Micronetа viaria (Bl.)		++	+	+	+
Maro minutus O.P.-C.		+	+	+	+
M. sublestus Falconer	R	-	-	+	-
Centromerus sylvaticus (Bl.)		++	+	+	-
C. expertus (O.P.-C.)		+	+	+	+
C. prudens (O.P.-C.)		++	+	+	-
C. arcanus (O.P.-C.)		+	-	-	-
C. dilutus (O.P.-C.)		+	++	+	+
Centromerita bicolor (Bl.)		+	++	+	++

TABLE 1 cont'd Species	Part of Reserve			
	Inchcailloch	Mainland		
		grassy wood	mossy wood	open
Sintula cornigera (Bl.)	R +	-	-	-
Oreonetides abnormis (Bl.)	++	++	+	+
O. firmus (O.P.-C.)	R +	+	-	-
Macrargus rufus (Wider)	++	++	+	-
Bathyphantes approximatus (O.P.-C.)	-	+	+	+
B. gracilis (Bl.)	+	++	+	+
B. parvulus (Westr.)	+	+	+	+
B. nigrinus (Westr.)	+	-	+	+
Kaestneria dorsalis (Wider)	+	+	+	+
K. pullata (O.P.-C.)	-	-	-	+
Diplostyla concolor (Wider)	+	-	-	-
Drapetisca socialis (Sund.)	+	+	+	-
Tapinopa longidens (Wider)	+	+	-	-
Labulla thoracica (Wider)	+	+	-	-
Bolyphantes luteolus (Bl.)	++	+	+	-
B. alticeps (Sund.)	R +	+	+	-
Lepthyphantes leprosus (Ohlert)	-	+	-	-
L. minutus (Bl.)	+	+	+	+
L. alacris (Bl.)	++	++	+	-
L. obscurus (Bl.)	+	+	-	-

TABLE 1 cont'd Species	Part of Reserve			
	Inchcailloch	Mainland grassy wood	Mainland mossy wood	Mainland open
L. tenuis (Bl.)	+	+	+	+
L. zimmermanni Bertkau	+++	+++	++	+
L. cristatus (Menge)	+	++	++	+
L. mengei Kulczynski	+	-	+	+
L. flavipes (Bl.)	+	-	-	+
L. tenebricola (Wider)	++	++	+	-
L. ericaeus (Bl.)	+	+	+	+
L. pallidus (O.F.-C.)	+	-	-	-
L. pinicola Simon R	-	-	-	+
L. angulatus (O.P.-C.)	+	-	+	-
Helophora insignis (Bl.)	++	+	+	-
Linyphia triangularis (Cl.)	+	+	+	+
L. hortensis Sund.	++	+	+	-
L. (Neriene) montana (Cl.)	-	+	+	+
L. (N.) clathrata Sund.	-	+	+	-
L. (N.) peltata Wider	+	+	+	+
Microlinyphia pusilla (Sund.)	-	-	+	+
M. impigra (O.P.-C.)	-	-	+	-
Allomengea scopigera (Grube)	+	+	-	+
A. warburtoni (O.P.-C.)R	-	-	+	+
Number of spider species:	129	102	108	81

TABLE 1 cont'd	Part of Reserve			
Species	Inchcailloch	Mainland grassy wood	mossy wood	open
PHALANGIDA				
Nemastoma bimaculatum (Hermann)	+++	++	++	+
Mitostoma chrysomelas (Hermann)	+	-	-	+
Mitopus morio (Fabricius).	++	+	+	+
Oligolophus tridens (C.L.K.)	+++	++	+	+
O. agrestis (Meade)	+	++	+	+
O. hansenii (Kraepelin)	+	+	+	-
O. meadii (Cambridge)	+	+	+	-
O. (Odiellus) palpinalis (Herbst)	++	++	+	+
Lacinius ephippiatus (C.L.K.	+++	++	+	+
Phalangium opilio (L.)	-	+	-	-
Platybunus triangularis (Herbst)	++	+	+	-
Megabunus diadema (Fabricius)	+	-	+	+
Number of phalangid species:	11	10	10	7
Total number of species:	140	112	118	88

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MINK PREDATION OF SHELDUCK AND OTHER WILDFOWL AT LOCH LOMOND

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Nature Conservancy Council

An initial study of the large inland breeding colony of Shelduck *Tadorna tadorna* on Loch Lomond was begun in 1975. The aim of the study was to investigate the use made by Shelduck of the Loch Lomond National Nature Reserve, the breeding biology and social organisation of the population, and the relationships between this population and that of the Clyde Estuary.

The most important Shelduck area on Loch Lomond is at the south-east corner of the loch. Here the River Endrick enters the loch, carrying with it a variety of aquatic plant and animal life. Partly as a result of this and the relatively warmer and shallower water, the area is rich in breeding and wintering wildfowl and waders. It also forms an important staging point along a main north-south migration route for a wide range of bird species. The area of marsh, fen and farmland at the mouth of the river, together with the wooded islands of Inchcailloch, Torrinch, Clareinch, Creinch and Aber Isle, form the Loch Lomond National Nature Reserve. Breeding Shelduck hold territories along the sandy shores of Ring Point and Crom Mhin Bay. Tern Island, Wards Ponds and Net Bay are important loafing areas for a residual non-breeding flock and for failed breeders (see Map 1). The main nesting areas are the wooded islands of the loch. The total Loch Lomond population has fluctuated between 80 and 120 birds during the years 1975-1978.

Feral American Mink *Mustela vison* are well established in the wild in Scotland, being present in all the mainland counties except Sutherland and Caithness (Cuthbert, 1973). This spread has been a result of the postwar boom in Mink farming and subsequent escapes from Mink farms. After initial efforts to control feral Mink by trapping, the Department of Agriculture and Fisheries for Scotland's effort was withdrawn in 1970. At Loch Lomondside a Mink farm was operational at Fintry until 1968, and escapes were strongly suspected when Mink began to colonize the River Endrick and its tributaries from 1964 onwards (J. Mitchell, *personal communication*).

Until 1970, feral Mink appeared to be restricted to the Rivers Endrick and Blane. The first record of Mink at the Endrick mouth was obtained in May 1971; there was a gradual build-up in numbers seen or trapped during the next few years, and Mink were

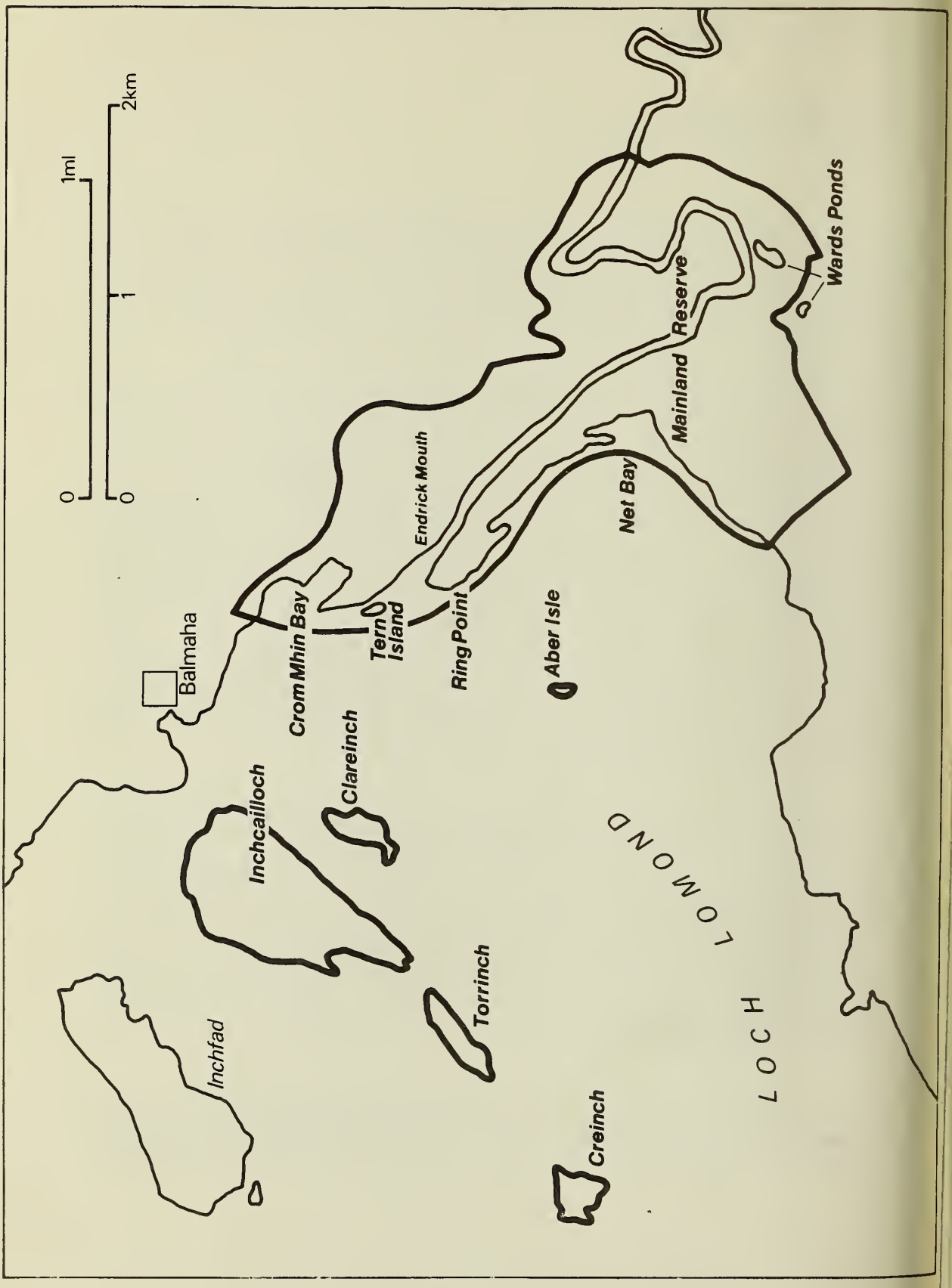

Figure 1: Loch Lomond National Nature Reserve.

recorded from the head of Loch Lomond in April 1974. In 1975 three were killed at Wards Farm, adjoining Loch Lomond Nature Reserve (R. Shaw, *personal communication*), and in 1976 eight were killed on the River Fruin and six at Rossdhu (Waltho, 1977). During the years 1977 and 1978 it has been estimated that sixty were killed in each year on the rivers Endrick and Blane (J. Theaker, *personal communication*). In 1978 fifteen Mink were killed at Wards Farm, bringing the total there for the years 1975-1978 to thirty Mink.

Throughout the Shelduck study a series of observations of wildfowl predation has been made. For example, in June 1976 a partially eaten female Shelduck was found outside a known nest-site on the island of Torrinch, and Mink scats were found beside the kill. During the same season two nests were deserted in the same part of the island during the final stages of incubation. In May 1977 an abnormal number of kills of Wigeon *Anas penelope* and Curlew *Numenius arquata* were found at the Endrick mouth, and a Mute Swan *Cygnus olor* was predated on the nest at Net Bay. In addition, a female Shelduck was found dead on her territory at the Endrick mouth. The Shelduck had been killed by a bite at the throat and a Mink was strongly suspected of being responsible. In addition to these observations, there is a documented account of a Mink attempting to kill a Mallard *Anas platyrhynchos* at the Endrick mouth (Christie, 1974), and a record of two Mink pursuing a Goosander *Mergus merganser* with a brood of ducklings at Cailness, Tarbert (Mitchell, 1978).

At Wards Farm Mink predation on the private wildfowl collection has been regularly recorded in recent years (R. Shaw, *personal communication*). For example, in 1977 a Mink killed a Cackling Canada Goose *Branta canadensis minima* on its nest on a small island, and ate six eggs. The remaining four eggs were placed under an incubating Bantam in a shed next to the house. A Mink later entered the shed, killed the Bantam, and took the eggs.

During the same year, a Mallard in moult was seen killed by a Mink, and in 1978 a Mink lived on moulting Mallards until finally shot on 8th September; the same individual had also been suspected of killing four Bean goslings *Anser fabalis* and four hybrid Canada Geese *Branta* sp.

The last Mink shot at Wards in 1977 was seen catching and killing a Pied Wagtail *Motacilla alba* which was washing in a small stream.

These direct and indirect observations of Mink predation culminated in May 1978, with the discovery by the author of a Mink with a freshly killed female Shelduck in a cavity under a fallen Scots Pine on North Hill, Inchcailloch. At the entrance

were wisps of Shelduck down, a sign which often betrays nest sites, or holes and recesses where ducks have been prospecting. The Mink was bold, inquisitive and reluctant to leave its kill, and did not bolt until the dead bird was pulled from the hole. The duck was in breeding condition and had been killed at the neck, which was partially eaten.

Studies of the feeding habits of feral Mink have established that they predate heavily on birds (Day and Linn, 1972; Gerrell, 1968). Predation is heaviest where Mink territories overlap areas with high populations of wintering, migratory or breeding birds, particularly wildfowl. From an analysis of 204 Mink alimentary canals Day and Linn (1972) have shown that approximately one third of the Mink's diet in England and Wales is composed of bird items. Mink are catholic feeders, and take whatever prey is abundant and easily caught. In Day and Linn's study, Coots *Fulica atra* and Moorhens *Gallinula chloropus* contributed almost half of the avian items identified, a reflection of their availability (and vulnerability) on the river systems sampled. Similar studies from a range of locations in Scandinavia have established that approximately 30% of the Mink's diet there is composed of avian material (Gerrell, 1961). The proportion varies through the year, being higher when breeding, or passage and wintering, birds are available. In one of the Swedish study areas, Lake Krankesjon, where there is a high density of breeding wildfowl, the occurrence of avian material in Mink scats was 66%, the contribution of wildfowl (mainly *Anas* species) being 51%. In a recent article reviewing the impact of Mink, Linn and Channin (1978) concluded that "the Mink's effect on bird populations seemed to be undesirable".

The opportunist predation by Mink on wildfowl during migration or on the winter grounds is not likely to cause a great threat to these species. Although large flocks of birds may be encountered, they are generally less vulnerable than during the breeding season, and birds predated from wintering flocks are most likely to be weak or ailing individuals. In addition, during autumn and winter fish, being cold blooded and more vulnerable at this time of year, form a greater proportion of the Mink's diet.

The evidence of Mink predating Shelduck on the breeding grounds poses a more serious threat. Studies on the annual cycle of behaviour of Mink (Gerrell, 1970) point out that they become more active (especially males) in spring and autumn, and range widely, often far from water, during this time. This behaviour is synchronised at Loch Lomond with the arrival and nest occupancy of Shelduck. Moreover, there must be a high probability of chance encounters between Mink and Shelduck, since both occupy holes or recesses for breeding. Of twelve Shelduck nests found on the Loch

Lomond National Nature Reserve during the 1975-78 period (Bignal, in preparation), four have occurred amongst rocks or on boulder scree slopes, six at the base of trees or under the upturned roots of fallen trees, one in a Woodrush *Luzula sylvatica* tunnel (an old Jackdaw *Corvus monedula* nest), and one in a disused rabbit-burrow.

When an incubating Shelduck is discovered or threatened on the nest, she invariably responds by repeatedly stretching her neck towards the intruder and often accompanies this with foot stamping. The outstretched neck would be an open invitation for Mink to attack.

The potentially harmful effects of Mink predation on the seabird colonies of offshore islands has been accepted (Linn and Chanin, 1978) and the recent refusal of planning permission for a Mink farm on Westray, Orkney, well publicised.

Until the spread of Mink to Loch Lomond, ground nesting birds on the islands were almost immune from mammalian predators. Other species breeding on Loch Lomond likely to be at risk, as a result of the synchronisation of mutual breeding behaviour and the high probability of chance encounters with feral Mink, are Goosander *Mergus merganser*, Red-breasted Merganser *Mergus serrator*, Common Scoter *Melanitta nigra* and Capercaillie *Tetrao urogallus*, as well as Teal *Anas crecca*, Wigeon *A. penelope*, Mallard *A. platyrhynchos*, Tufted Duck *Aythya fuligula*, Shoveler *Anas clypeata*, terns *Sterna spp.*, Coot *Fulica atra* and Moorhen *Gallinula chloropus*. Although seabird breeding colonies on offshore islands are undoubtedly at high risk from the introduction of Mink, because of the lack of existing predators, the rich breeding populations of wildfowl which occur on mainland Britain and especially in Scotland must, by necessity, also be threatened. It has been suggested that the predation effect of Mink may not be significant, since it does not introduce a novel way of predating but overlaps with existing native predators, such as Weasel *Mustela nivalis*, Stoat *Mustela erminea*, Polecat *Mustela putorius*, Otter *Lutra lutra* and Fox *Vulpes vulpes* (Linn and Chanin, 1978). The distribution of these indigenous predators is by no means ubiquitous and would not have been in the past. The impact of Mink on areas like Loch Lomond, however, is likely to be equivalent to introducing a predator combining many of the specialist predation skills of all the above species.

The feral Mink is now numerous in Britain, and is increasing and gradually adapting its habits to exploit the most abundant and easily available prey. Few studies on the effects of Mink predation on areas with rich breeding bird populations have been attempted, and information on the Mink's activities is often indirect or anecdotal; for instance, scat analysis or the evidence of a

fall in breeding bird population at a time when Mink are obviously increasing. To date, it is difficult to point specifically to populations of avian (or other) species which are threatened by Mink predation. Most studies of Mink, however, have not concentrated on areas rich in wildlife, and have taken samples from a wide sample area. Britain, especially where intensively farmed, is today intrinsically poor in wildlife and it is often only on areas such as Nature Reserves that natural or semi-natural plant and animal communities survive. Whilst the effect of Mink predation in the countryside generally may not be detrimental, its effects on these rich areas must be more significant. Indeed, Linn and Chanin (1978) specifically point to the detrimental effect Mink can have on exotic wildfowl collections. The rich breeding colonies of wildfowl extant in Britain today, if viewed in the context of the general countryside, could be considered analogous to these collections and likely to suffer similar effects.

As feral Mink increase and widen their distribution, their effect on areas of high wildlife importance will increase. The acceptance of Mink in the British countryside generally may in the future have serious implications for these 'islands' of high wildlife interest, where trapping or shooting of Mink will be necessary to control the effects of predation. Whilst it may be possible to do this and satisfactorily sustain the features of interest, the cost of such control will be high. Moreover, this control will be a recurrent commitment, since colonisation from outside the area will always take place.

A comprehensive bibliography on Mink was prepared by the Nature Conservancy Council Library Services for staff involved with the Westray public inquiry. Copies are available on request from the Librarian, Nature Conservancy Council, Calthorpe House, Calthorpe Street, Banbury, Oxon, OX16 8EX.

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THE FOOD OF SHORT-EARED OWLS IN ORKNEY

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Introduction

Sufficient analyses of pellet samples have been made over the past two decades to allow a synthesis of Short-eared Owl feeding habits; such a collation has recently been made by Glue (1977), whose main conclusion is that in many regions of Britain the Short-tailed Vole (or a close relative) forms the great bulk of the Owl's diet. The present analyses are based on examination of over 200 pellets from Orkney (supplementing the apparent sample of eleven in Glue's paper) and enable a fairly reliable breakdown of dietary components to be related to the local availability of prey species in the field.

As with most birds, the diet of the Short-eared Owl *Asio flammeus* is likely to be the result of one of two feeding strategies: either selection of a preferred species from a variety of prey species, or predation, with no selection, on all the prey species available. Pellet analyses will show one of three trends:-

(a) a wide variety of species represented, probably indicating no positive prey selection by the owls;
(b) one (or two) dominant prey species, arising from active prey selection from a variety of prey available;
(c) one (or two) dominant prey species, arising from the fact that these form the vast bulk of prey individuals available.

The only way to distinguish between these is to relate pellet analyses to data on prey availability, but the field-study of small mammals has its (well known) drawbacks and to obtain an index of species abundance presents sufficient problems to dissuade many researchers from attempting it contemporaneously with pellet collections.

In Orkney Short-eared Owls are not uncommon (see, for example, Balfour (1974) and Lea and Bourne (1975)) and are often to be seen hunting by day over moorland and rough pasture: one can almost guarantee that birds will be seen over certain specific areas every time one passes. It was on one such area that the present observations were made, to obtain data on the food of the Short-eared Owl which could be compared with data from other

studies. In addition a few data were collected on small mammals present in the same area, and other small mammal information was also used, from habitats almost identical to this, to enable the feeding strategy to be elucidated.

Prey abundance in the diet

In Orkney, the field vole niche is occupied, not by the Short-tailed Vole *Microtus agrestis*, but by the Orkney Vole *M. arvalis*. They are abundant over the whole of the Orkney mainland, with subspecies present in four of the outlying islands (Berry and Rose, 1975). These are not the only small mammals available to the Short-eared Owls by any means (see later), and there was no reason to suppose that the chosen study area in Tankerness differed in any way from the small mammal habitats on the rest of Orkney. The study area was adjacent to an old peat-working patch of moorland on which heather *Culluna vulgaris* was the dominant plant species. Two pairs of Owls occupying the area hunted over a quarter square kilometre of rough pastureland and moorland, and the pellets of the Owls present were collected over a period of two years.

The basic data (Table 1) were grouped into four periods - summers and winters - during which time 205 pellets examined contained evidence of 300 prey individuals. Of these, 248 (82.7%) were Orkney Voles. Using Southern's (1954) conversion factor (which ranks small mammals in prey units according to size), the nutritional status of each species represented was calculated (Table 2).

Table 1: Seasonal Distribution of Pellet Collections

Period	Number of Pellets	Number of Items	Number of Voles
Winter 1973-74	42	75	65
Summer 1974	70	104	82
Winter 1974-75	69	93	77
Summer 1975	24	28	24
	205	300 (1.46 items per pellet)	248 (1.2 per pellet)

N.B. "Winter" = October to March (inclusive)

Table 2: Pellet Analyses

	% Representation in pellets			
	Numerical		Prey units	
	This study	Glue (1977)	This study	Glue (1977)
'small vole'	82.7	64.3	56.0	45.7
Brown rat	5.0	8.9	17.0	31.5
Rabbit	7.0	0.4	24.0	5.2
Pygmy Shrew	2.0	1.9	0.3	0.3
Wood Mouse	2.0	9.5	1.4	6.7
House Mouse	1.0	0.2	0.7	0.2
Birds	0.7	9.9	0.5	7.0

Table 3: Analysis of Prey by Season; Percentage values of data converted as per Southern (1954).

Species	Winter* 1973 - 74	Summer 1974	Winter 1974 - 75	Summer 1975
Orkney Vole	62	54	55	55
Brown Rat	4	14	28	22
Rabbit	29	30	14	22
Pygmy Shrew	-	0.6	-	-
Wood Mouse	2	0.6	2	-
House Mouse	2	0.6	-	-
(Birds)	-	0.6	0.7	-

* Winter months were October to March inclusive. Dashes indicate absence of prey species in that particular sample.

Thus, while Voles formed the majority of prey items, from the nutritional point of view Rats *Rattus norvegicus* and young Rabbits *Oryctolagus cuniculus* were together almost as important in the Owl diet as the Voles. Such a preponderance of Rabbits is apparently similar to only one other recorded sample, from Wales (in 1939) (Glue, 1970).

The Orkney figures can be broken down further on a seasonal basis (Table 3).

Voles formed a consistently high proportion of the diet, whilst Rats were a variable nutritional component (4-28%). Rabbits, however, were obviously a more important item through the year (with slightly higher indices in summer than in winter), possibly a reflection of the availability of young Rabbits - a species capable of producing young over a considerable part of the year (Thompson and Worden, 1956). The other small mammals and birds did not form major contributions to Owl diet in Orkney.

Size of prey items

A standard morphometric measurement (length of right upper tooth row; see Southern, 1964) was used to estimate the sizes of Voles and other small mammals taken by the Owls. Represented in only small numbers were the Pygmy Shrew *Sorex minutus*, Wood Mouse *Apodemus sylvaticus* and House Mouse *Mus musculus*; tooth row measurements for these species are given for interest in Table 4, as also data on Rat skulls. A more comprehensive analysis was possible with the Voles (Table 5) which showed that larger voles were being taken in summer than in winter. Available information suggests that Voles in Orkney probably begin to breed about May, stopping in autumn at which time also the adults tend to die, leaving mainly the young of the year to overwinter (Robertson, 1977).

Table 4: Skull sizes for Four Prey Species (excluding Voles)

Species	Number of skulls examined	Right upper tooth row (mm ± s.d.)
Pygmy Shrew	5	4.30 ± 0.14
Wood Mouse	6	4.05 ± 0.62
House Mouse	3	3.97 ± 0.98
Brown Rat	14	8.02 ± 1.72*

* This represents Rats of sub-adult size (Southern, 1964)

Table 5: Seasonal Variation in Vole Skull Size (pellet remains).

Period	Number of skulls examined	Right upper tooth row (mm ± s.d.)
Winter 73/74	40	6.64 ± 0.41
Summer 74	39	6.85 ± 1.06
Winter 74/75	58	6.13 ± 0.47
Summer 75	20	6.95 ± 0.47

Significant statistical difference between combined Summers and Winters ($p < 0.01$).

Relative abundance of prey species

As far as I can judge, no attempt at an accurate estimate of Short-eared Owl prey abundance has been made in Britain to date, and any analyses of small mammal abundance are subject to various assumptions. Among these are the problems of trap-shy and trap-happy individuals and possible age differences of animals entering traps. These difficulties should be borne in mind whenever (as now) relative abundance is being discussed. Thus no large-scale population study of Orcadian small mammals is available at present, but a few data were collected during the course of this study, and in addition, J.G.M. Robertson (*in litt.*) and F.E.N. Rose (*in litt.*) have made available data on small mammals in very similar Short-eared Owl habitats on the Orkney mainland (Table 6).

Conclusions

Overall it seems that the Owls were tending to take prey species in approximately the same proportion as their availability in the field (Table 7), but often selecting items of larger size which were of greater nutritional value in terms of hunting efficiency; there was no obvious seasonal pattern as regards predation on Rats and Rabbits.

The dominance of Voles in these Orkney samples (confirmed both by Booth, personal communication, and in the manuscripts of the late Eddie Balfour) parallels trends from elsewhere (Glue, 1977), but some comparisons can be made between results from this study and Glue's summary data. In most places the Short-tailed Vole predominated; island groups, e.g. Western Isles (Jeal, 1976), also showed this feature. In regions where this Vole is absent other species were of greater importance; this

Table 6: Relative Abundance of Small Mammals Trapped (using Longworth traps).

	Relative abundance of each species trapped (%)		
	Present Study	Rose (*in litt.*)	Robertson (*in litt.*)
Number trapped	44	315	114
Orkney Voles	86.3	93.6	72.0
Wood Mouse	2.3	0.6	14.0
House Mouse	2.3	4.4	0.0
Brown Rat*	6.9	0.3	0.9
Pygmy Shrew	2.3	0.9	13.0

* Adult Brown Rats were too large to be caught in the traps.

Table 7: Comparison of Species Abundance (%) in Pellets and in Traps

Prey Species	Numerical		Prey units	
	Pellets	Traps	Pellets	Traps #
Vole	82.7	87.7	56.0	86.8
Wood Mouse	2.0	4.0	1.4	3.9
House Mouse	1.0	3.2	0.7	3.1
Pygmy Shrew	2.0	4.0	0.3	0.8
Brown Rat	5.0	1.1	17.0	5.3
Rabbit*	7.0	-	24.0	-

* No Rabbits caught in traps.

Derived from pooled data in Table 6.

tendency was high-lighted in Orkney, where the Orkney Vole was proportionally greater in importance than the Short-tailed Vole elsewhere (Table 2), both in terms of numbers and of weight units. Rabbits also comprised a higher percentage of the diet than in other samples. On the other hand, birds were of lesser significance to the Orkney Short-eared Owls and seasonal analyses showed great dietary stability in Orkney - particularly as regards the Voles.

Though local prey availability presumably leads to local variation in diet composition, it is likely that Short-eared Owls feed mainly on the predominating small mammal, usually that occupying the 'small vole' niche; and these Orcadian data support Glue's findings to this effect whilst showing interesting differences regarding Owl predation on mammals of slightly larger size than Voles.

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Summary

Examination of 205 Short-eared Owl pellets from a moorland type habitat in Orkney revealed that 83% prey items were Orkney Voles, but in weight unit terms (obtained by the use of a conversion factor system) this prey species accounted overall for 56% of the diet, with Rats and young Rabbits providing 41% diet by weight. Though no firm data are available on the relative abundance of Rats or Rabbits, analysis of small mammal results from trapping suggests that the Owls were probably taking small food items in roughly the proportion in which they were present in the feeding habitat.

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BREEDING OF THE STORM PETREL AND THE MANX SHEARWATER IN KINTYRE, ARGYLL

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In summer 1974 I came to live near Campbeltown and immediately became interested in the birds of the Kintyre peninsula. I paid particular attention to the islands of the Sanda group and Davaar, and during 1977 and 1978 I found evidence of the breeding of both the Storm Petrel and the Manx Shearwater, as follows. An intensive campaign of trapping and ringing Storm Petrels, using mist-nets and tape lures, was also instituted, and details of this will be reported in due course.

STORM PETREL *Hydrobates pelagicus*

On 2nd June 1976 I found over seventy wings of the Storm Petrel in and around a small cave on the storm beach at Prince Edward's Rock, Island of Sanda (55° 17'N, 5° 34'W) which lies at the entrance to the Firth of Clyde some one and a half miles off the south-east tip of the Kintyre peninsula. Subsequent observations led me to believe that the petrels had probably been killed by a cat.

During the summer of 1977 I spent a considerable time on the island, mainly for ringing purposes, and on 18th July 1977 breeding was confirmed when excavation of a suitable area of storm beach revealed several incubating Storm Petrels. Several other incubating petrels were found in 1978, and one bird trapped on 22nd July 1978 actually laid an egg in the bird bag! From my other observations I think it quite likely that Prince Edward's Rock is not the only breeding site on Sanda, since there are many other suitable storm beaches on the island. Moreover, the two neighbouring islands in the Sanda group, Sheep Island and Glunimore, each with suitable territory, have still to be investigated.

During 1977 and 1978, using mist-nets and tape lures, nearly a thousand Storm Petrels were trapped and ringed at Prince Edward's Rock. All birds caught were thoroughly examined, particularly in the area of the brood patch. The majority of the birds caught in May-June had their brood patches completely free of feathers and down, and many showed signs of vascularisation. From the ringing evidence and brood patch examination the Sanda colony has provisionally been placed in the lower order 3 (101-500 breeding pairs).

Many of the birds caught in July and August of both years, however, were regarded as pre-breeders/wanderers, since examination of these birds showed that their brood patches were not large or bare enough to indicate the likelihood of breeding. All had a brood patch of sorts, but in the majority this was extremely difficult to locate and required four to six blows before being found. Recent experiments by A.R. Mainwood on the Summer Isles, Wester Ross, has shown that wanderers are more readily attracted to the tape recorder than breeders (B.T.O. *Ringers' Bulletin,* Vol. 5, No. 3, 1978).

A good many of the Sanda birds were retrapped. Indeed, of the initial trapping of 32 Storm Petrels, ringed in May-June 1977, no fewer than 21 were retrapped, 17 in July and four in August. All were retrapped where originally netted, thus showing the fidelity recorded by breeding birds.

Five Storm Petrels controlled on Sanda in 1977, and six in 1978, had been ringed at Copeland Bird Observatory, County Down, 66 km south of Sanda. As far as is known, Storm Petrels do not breed on the Copeland Islands so these birds were presumably pre-breeders/wanderers when caught. Other Sanda controls were from The Calf, Isle of Man and Puffin Island, Kerry.

At the end of August and in early September 1978 along with Mr. R.P. Morton I visited Davaar Island at the entrance to Campbeltown Loch. This site was selected because of its position south of the Kilbrannan Sound, where Storm Petrels have recently been noted in increasing numbers. On three nights, 23rd and 24th August and 7th September, again using mist-nets and tape lures, 118 Storm Petrels were trapped and ringed; seven ringed birds from Sanda were controlled. Brood patch examination, however, and lack of retraps, indicated that Storm Petrels did not actually breed on Davaar, and that the trapped birds were lured off the sea by tape recordings of the churring; this also points to wandering behaviour.

In the Clyde area Storm Petrels formerly bred on Ailsa Craig, probably until about 1900 (Gibson, 1951-52), but no other Clyde breeding sites were known to Dr. Gibson in his Clyde Seabird Survey (Gibson, 1976). Prior to the discovery of this colony on Sanda the nearest known breeding site was at Rathlin O'Birne, Co. Donegal, in the West of Ireland (Cramp, Bourne and Saunders, 1974).

MANX SHEARWATER *Puffinus puffinus*

Large rafts of Manx Shearwaters have long been well known in the lower reaches of Clyde (McWilliam, 1936; Gibson and McWilliam, 1959), and have also been described just off the Island

of Sanda, Kintyre, by Gibson (1956 and 1957) and Bain (1958). At present these rafts of Manx Shearwaters occasionally reach some 200-300 birds off Sanda in the late evening.

In the course of many night watches on the Island of Sanda during the summers of 1977 and 1978, many Shearwaters were heard 'crooning' at Prince Edward's Rock and near Wallace's Rocks, and on 31st July 1978 Mr. R.P. Morton and I located a Manx Shearwater incubating its single egg in a shallow burrow by a very steep grass slope near Prince Edward's Rock. So far this remains our only proof of breeding, but from the evidence of the numbers of birds seen it is not unreasonable to assume a small breeding colony.

On 23rd and 24th August and 5th and 7th September 1978 several Manx Shearwaters were seen frequenting the east cliffs of Davaar Island at the entrance to Campbeltown Loch. At least seven birds were seen on the night of 5th September, and birds were seen landing on the cliffs on the first three nights. Judging from the amount of calls and shuffling noises heard on the cliffs, however, it was clear that many more birds were involved, and from our experience it seems quite possible that Manx Shearwaters may also breed on Davaar Island, but from the inaccessible nature of the site this may be very difficult to prove.

The only previous positive record of breeding from the Clyde area comes from the rock stack of Glunimore, half a mile N.E. of Sanda, where on 2nd September 1955 Dr. J.A. Gibson managed to dig out two nearly fully-fledged young Shearwaters; at the time he made a 'guess' from the numbers of birds seen around the island that possibly about a dozen pairs nested (Gibson, 1957). Later, in his Clyde Seabird Survey, Dr. Gibson published full details with information about the Shearwaters' decurved bill-tips and other diagnostic points. The rock fall on Glunimore in the early 1960s (*Trans. Buteshire Nat. Hist. Soc.*, 17: 84) was assumed to have destroyed this colony, but I myself have still to investigate this site.

The Manx Shearwater, therefore, has now been shown to breed on two Kintyre islands, Sanda and Glunimore, and may possibly breed on Davaar. Sheep Island has still to be investigated. From the numbers of Shearwaters seen in south-east Kintyre waters in the breeding season, however, it would not be unduly surprising if Shearwaters were ultimately proved to breed on all four south Kintyre islands. Investigations will continue.

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COLLOCHERES ELEGANS, A CYCLOSTOME COPEPOD INFESTING OPHIOCOMINA NIGRA IN THE FIRTH OF CLYDE

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Introduction

During January 1972 large numbers of the cyclostome copepod *Collocheres elegans* Scott were recovered from the brittlestar *Ophiocomina nigra* Abildgaard. *C. elegans* was first described by Scott (1896) from a single female specimen collected in dredged material from the Isle of Man. Sars (1915) subsequently collected a few females from 20 fathoms off the west coast of Norway. He placed *C. elegans* in the new genus *Leptomyzon*. The male was first described by Grainger (1950), who recovered large numbers of male and female specimens from *O. nigra* at Keppel Pier, Millport. Stock (1966) concluded that the genera *Collocheres* and *Leptomyzon* were synonymous, but apparently based his conclusions on examinations of material of *Collocheres gracilicauda* (Brady), *C. uncinatus* (Stock) and *C. breei* (Stock). The large infestation rate of *C. elegans* on *O. nigra* in the Firth of Clyde presented an opportunity to re-examine *C. elegans* and investigate aspects of its relationship with its host.

Materials and Methods

Specimens of *O. nigra* were collected by SCUBA diving on beds of this brittlestar in the Firth of Clyde. Twenty brittlestars were collected for each sample and placed immediately in a screwtop plastic jar. All depths were recorded using an SOS helium depth gauge, and are expressed in the text as metres below chart datum.

Monthly samples were taken on a brittlestar bed at the Keppel Pier, Millport, from January 1972 to July 1973 at a depth of 5 metres. All temperature recordings were of the surface water at Keppel Pier.

The brittlestars were washed in sea-water and then transferred to 90% alcohol to remove the copepods. The dead brittlestars were removed and measured, and the remaining alcohol was examined for copepods, which were identified, sorted into stages and stored in absolute alcohol. For taxonomic studies, 8 females and 6 male *Collocheres* were examined in detail.

In order to gain an index of fertility the egg number/egg case was measured from a sample of twenty egg-cases.

Taxonomy

Sars (1915) separated *Leptomyzon* from *Collocheres* on the basis of the structure of the oral cone, the fifth pair of legs and the caudal rami.

He described a pair of tentacular appendages apparently attached to the oral cone of *C. elegans*. These appendages were not described by Scott (1896) in his original description of *C. elegans*. I endeavoured to check the type specimen in the British Museum, but it could not be located. Grainger (1950), who undoubtedly studied the same species as is mentioned in this report, described such appendages in the male. Stock (1966), who apparently did not examine *C. elegans*, stated that in *C. gracilicauda* he "occasionally observed fleshy, nondescript lateral projections of the siphon" which on close examination proved to be maxillular setae. My own findings are in agreement with those of Stock. In one female specimen an apparently fleshy lobe was observed on one side of the siphon. It was probably a precipitate caused by the addition of alcohol to the sea-water, that had become attached to the siphon.

Sars (1915) does not state clearly why he considers the fifth leg to be a generic difference. Stock (1966) points out that the fifth leg of *C. canui* which Sars considers as a *Collocheres* and not as a *Leptomyzon*, does not differ much from that of *C. elegans*. In the present work it was found that both Scott's (1896) and Sars' (1915) descriptions of the proximal joint of the fifth leg being triangular in form are not in accordance with the material from the Firth of Clyde. Figure 1a shows the fifth leg after Sars. The shape of the proximal joint of Millport specimens is more rhomboidal, being similar to that of *C. gracilicauda* figured by Stock (1966). Scott (1896), however, considered the fifth leg to be one of main characters for separating *C. elegans* from *C. gracilicauda*.

Likewise Stock (1966) did not consider the caudal rami to be of generic significance and notes that female *C. breei* have *Collocheres* type rami, and male *C. breei* have *Leptomyzon* type rami. He further concluded that Sars missed a lateral seta in his description of *L. elegans*. My own observations are in agreement with those of Sars, since I was unable to locate the lateral seta mentioned above.

I conclude from the material examined that Stock (1966) was correct in reuniting *Leptomyzon* with *Collocheres*.

Site of Infestation

Under a low-power binocular microscope *C. elegans* was readily seen on the host darting between the arm spines and over the disc.

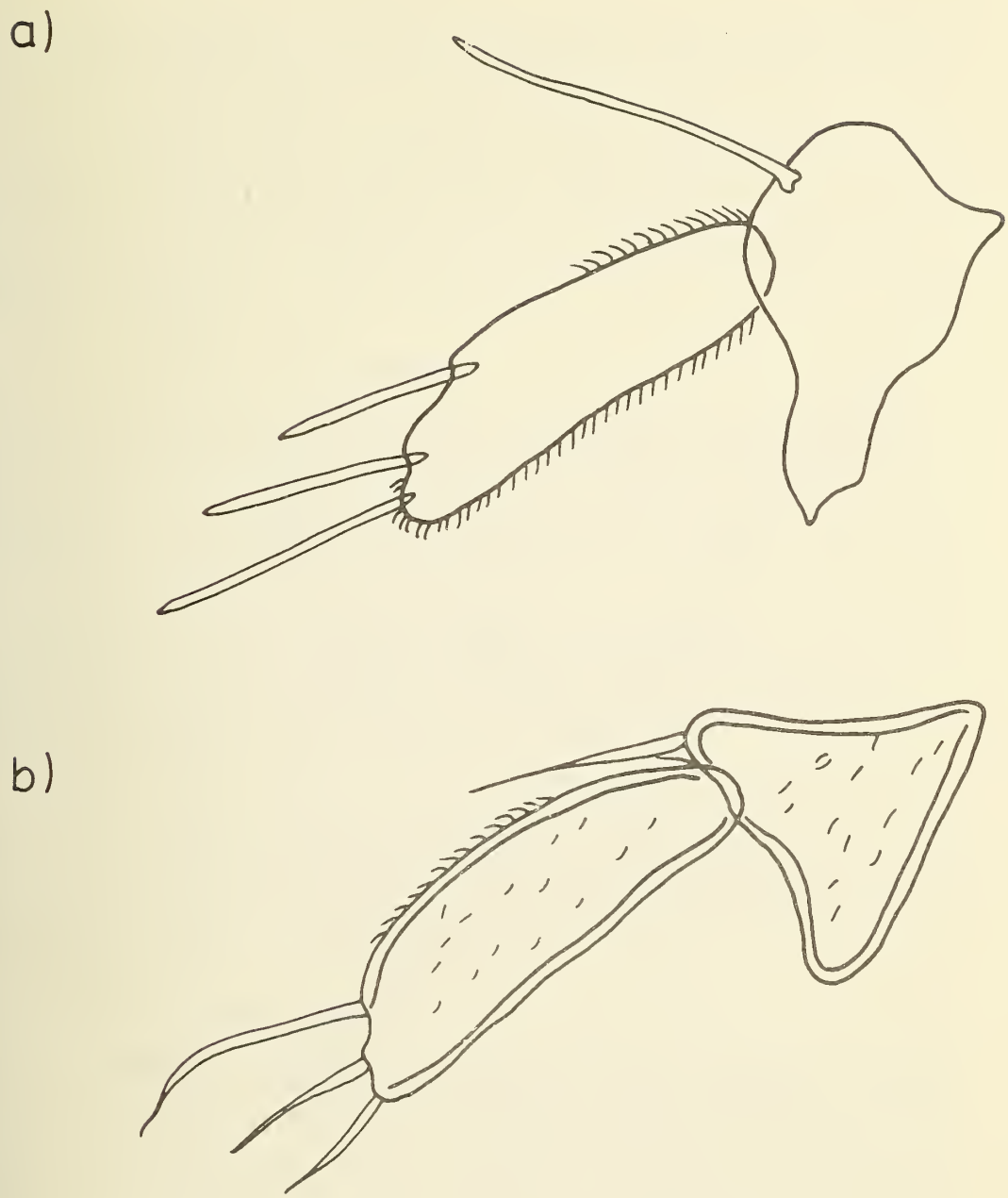

Figure 1: The fifth leg of a female *Collocheres elegans*.

(a) Millport specimens

(b) After Sars (1915)

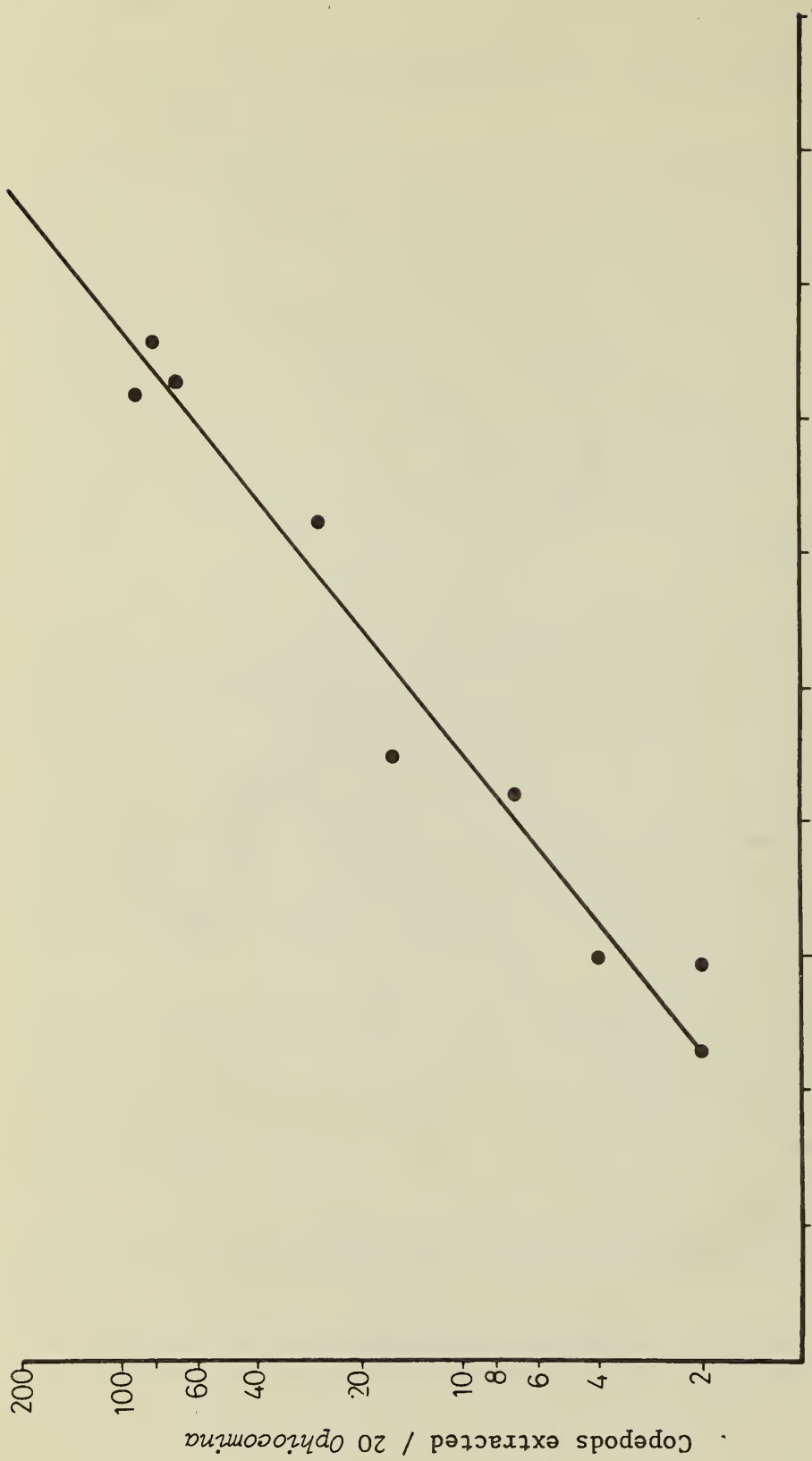

Figure 2: Infestation Rate of *Collocheres elegans* / 20 *Ophiocomina*.

The copepods did not leave the host, which could be washed several times in sea-water without dislodging them. Any disturbance caused the copepods to cling firmly to the host.

In order to investigate whether the copepods had a preferred site on the host, twenty *O. nigra* were each divided into discs, proximal halves of arms and distal halves of arms. The portions were immediately thrown into alcohol, and the numbers of the copepods extracted were 19, 44 and 23 respectively, indicating that they tend to stay at or near the arm bases of the brittlestars.

Infestation Rate and Host Size

Initial studies of the Keppel Pier population of *Ophiocomina* showed that all large brittlestars were infested with *Collocheres*, small brittlestars being generally free of infestation. In order to investigate seasonal infestation rate it was necessary to standardise the infestation rate with regard to host size so as to remove the size-dependency variable.

Figure II shows the infestation rate per 20 *Ophiocomina* plotted against the mean disc diameter of those 20. It can be seen that there is an increase of infestation rate with host size. The infestation rate has been plotted on a logarithmic scale, a straight line fitting to the points of the graph.

This graph was used as an arbitrary 100% infestation rate. For every sample, 20 large *Ophiocomina* of approximately the same size were selected and copepods extracted. The infestation rate was expressed as the percentage of the actual catch from 20 *Ophiocomina* divided by the expected catch in Figure 2 for the mean disc diameter of the sample taken.

Seasonal Infestation Rate

For the study copepods were divided into three classes: adult males, with hooked antennae and distinct genital segments; adult females, with or without egg-cases, with a fully-developed fifth leg; and juveniles. Thus all copepodite stages were included. The recovery of juveniles was too low to split them into sub-classes; at no stage were nauplii found. Figure 3 shows the seasonal infestation rate of *Collocheres* on *Ophiocomina* at Keppel Pier from January 1972 to June 1973. This is plotted with the infestation rate of the juveniles expressed as percentage of the catch, the mean egg number/egg case, and the mean monthly sea-surface temperature. The infestation rate varies inversely with the mean monthly sea temperature. The ratio of males to females did not change significantly throughout the year, males constituting 53% of the adult population. Between 60% and 70% of the adult fe-

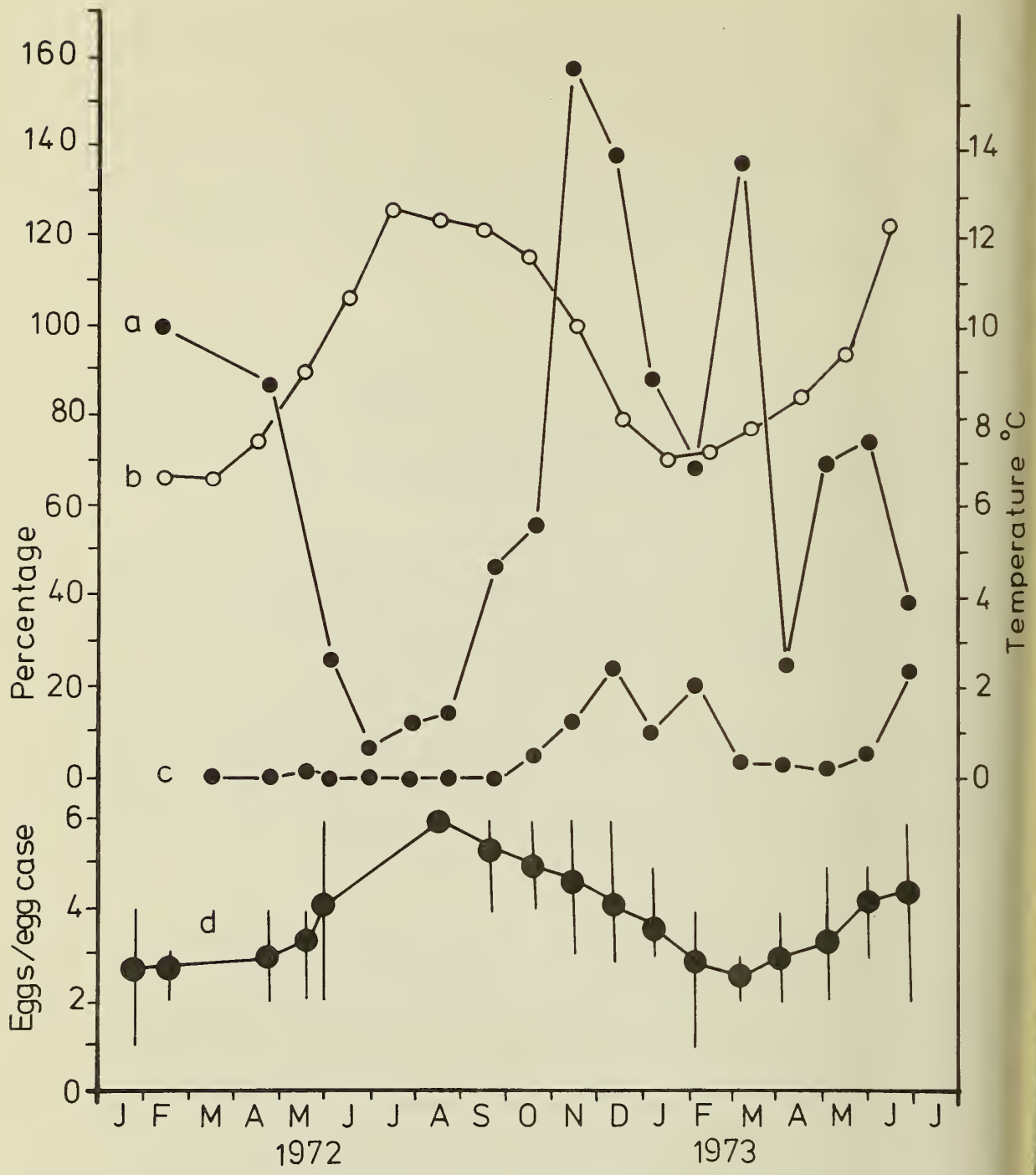

Figure 3:

(a) Seasonal infestation rate of *Collocheres elegans* on *Ophiocomina*.

(b) Mean monthly sea temperature.

(c) Juvenile copepods as % of catch.

(d) Egg number/egg case and range.

male copepods had paired egg-cases throughout the year. The egg number/egg case ratio ranged from 1 to 6, the highest mean egg number/egg case being found in July/August, and the lowest from January to March. The percentage of juveniles in the catch was at all times lower than the percentage of adults in the catch, but showed a slight rise in the winter months.

If the females were seasonal breeders the mean egg number/egg case ratio would be expected to drop suddenly, as would also the percentage of egg-carrying females. However, the gradual rise and fall of egg number/egg case suggests that the copepods were breeding all the year round, fecundity being higher in the summer. Could the rise from a 7% infestation rate in June 1972 to an infestation rate of 158% in November 1972 have been due solely to reproduction? Since females are almost 50% of the adult population, to achieve this result every female in June 1972 would need to produce 40 eggs assuming no mortality amongst young stages - in order to produce the 20- fold increase in the population. In June the mean egg number/egg case is about 4.5, rising to 6.0 at the end of August and falling to 4.9 in October. Thus each female would need to produce at least 4 pairs of egg cases between June and October. The fall-off of infestation rate in the spring may be due to copepod mortality.

The flaw in this interpretation, however, is the appearance of juveniles during the winter after the infestation rate has risen, which suggests immigration of young stages. Since the young were always recovered in very low numbers it must be concluded that the copepodites generally live in very loose association with the host. Bearing in mind that the original records of *Collocheres* (Scott 1896, Sars 1915) were of free-living specimens, and that there is no indication that they are parasitic when in association with *Ophiocomina*, it is worthwhile considering the possibility that the autumn rise and spring fall indicate immigration and emigration respectively. On this hypothesis it could be concluded that *Collocheres* lives in loose association with *Ophiocomina* in the summer. This suggestion should be investigated because the first explanation requires *Collocheres* to have its reproduction and recruitment completely out of phase with the sea temperature - a phenomenon that would be highly unlikely in a marine or fresh-water copepod.

It is not known at what stage the young are released from the egg. At no stage were embryos visible, presumably because of the opaque egg-envelope. The low catches of juveniles suggest they had a very loose association with the host.

Effect of Depth on Numbers of Eggs/Egg Cases

Samples were also taken from a brittlestar bed 29 metres

wide, starting abruptly at 9.1 metres and fading out at 15.3 metres depth. Table I shows the mean egg number/egg case taken at different depths on different dates. It can be seen from Table I that the mean egg number/egg case apparently falls with increase of depth and/or decrease of host density, but unfortunately this phenomenon could not be followed further. If the mean egg number/egg case is taken as an index of fecundity, at the Red Buoy station the change of fecundity at the deeper part of the band appears to be some weeks behind that at shallower depths.

Distribution

In addition to recovering *C. elegans* from *O. nigra* around the Isle of Cumbrae, specimens were also recovered from *O. nigra* from the south end of the Isle of Arran, Holy Isle (Arran), and the Eddystone grounds of Plymouth. Samples of *Ophiocomina* from the Isle of Man and Loch Sween did not yield any copepods.

Other Associates

Of 3,555 copepods examined, 3,535 were *C. elegans*, one was an unidentified harpacticoid of the family Tegastidae, and 19 were harpacticoids of the family Tisbidae. The tisbids included *Tisbe gracilis* (Scott), *T. furcata* (Baird) *T. tenera* (Sars) and one *Teissierella* (?) sp. Harpacticoid copepods have been recorded on other ophiuroids. Bresciani and Lutzen (1962) found *Thalestris longimana* (Claus) on *Ophiothrix fragilis* and *Ophiopholis aculeata*. Members of the genus *Tisbe* are scavengers (Hagerman, 1966), being normally associated with algae.

In addition to those copepods, several specimens of the amphipod *Aora typica* Kroyer, and one specimen of *Apherusa jurinei* (Milne-Edwards), were recovered.

The occurrence of species other than *Collocheres* is probably incidental.

Discussion and Conclusions

Of the parasites and associates identified from *Ophiocomina nigra*, only one, *Collocheres elegans*, occurred in any significant numbers. No evidence was produced as to the mode of feeding of *C. elegans*. It could be feeding ectoparasitically on *O. nigra*. Rottger *et al* (1972) have shown that *Asterocheres lilljeborgi* (Boeck), a siphonostome copepod living ectoparasitically on *Henricia sanguinolenta*, digests the host skin extraintestinally and sucks up the food via the siphon-shaped mouth parts.

On the other hand *C. elegans* could be a harmless associate on *Ophiocomina*, sharing the host food or feeding on mucus. Gotto

Table 1: Mean Egg Number / Egg Case of *C. elegans*.

Site	Depth (metres)	5.2.73	14.4.73	5.5.73	28.6.73	Density of *Ophiocomina*
Keppel	5.0	2.90	3.00	3.39	4.50	2000/m^2
Red Buoy	9.1	2.95	3.20	3.25	4.75	200/m^2
Red Buoy	12.2	2.40	2.60	3.05	4.35	170/m^2
Red Buoy	15.3	-	2.65	2.80	4.30	50/m^2

(1963) suggests that cancerillid copepods associate generally with bioluminescent brittlestars, and are perhaps therefore feeding on substances produced by the photogenic organs. *Ophiocomina* employs a mucous net in feeding (Fontaine, 1965). If the copepods were feeding on boluses of food being passed to the mouth, the arm bases would be the most favourable areas on which to sit. As has been shown, copepods leave the host during the summer. Consequently, unless they change their feeding habits when away from the host, it would seem likely that they are feeding in this fashion, rather than directly on the host tissue. *Ophiocomina* feeds on harpacticoid copepods (Fontaine, 1965), and a wide variety of zooplankton (Taylor, 1959). It is remarkable that *Collocheres* evades the very efficient mucous net to exploit this niche.

Little previous work has been published with regard to the reproductive ecology of cyclopoid copepods associated with echinoderms. Taylor (1959) recorded the cyclopoid copepod *Ophiothys amphiurae* (Herouard) from the bursae of *Amphipholis squamata*. She found eggsacs present from November to May, the embryos being released in May as copepodites. In *Collocheres elegans* it is concluded that they are breeding all year round but that the fecundity is higher in the summer. If *Collocheres* does in fact live in loose association with the host in the summer, the increased fecundity becomes an intriguing problem. It has been suggested by Gotto (1962) that parasitic copepods have low egg numbers when the host is easily accessible and when the copepod lives in close association with the host. Conversely he argues that a copepod with greater problems in finding its host has a higher egg number. It is tempting to interpret the seasonal fluctuation in egg number in *Collocheres* as mirroring the alternation between living in close and loose association with the host. However, physical conditions such as temperature may also have an effect on egg production, either directly or indirectly via variations in food supply. This holds true for certain pelagic copepods (Mauchline, 1972), the egg number often being related to absolute body size. The low number of copepods recovered during the summer months did not allow an examination of any variation in size of female copepods.

Acknowledgments

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GEOLOGY IN IRELAND BEFORE 1812: A BIBLIOGRAPHICAL OUTLINE

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Recently historians of science from many parts of the world have found a fruitful research field in studying the development of the earth-sciences within the British Isles. From Tokyo to Tulsa scholars are familiar with the achievements of James Hutton and his confreres of the Scottish School of Geology, or with the work of 'Strata' Smith and his distinguished English contemporaries of that brilliant circle associated with the Geological Society of London. The luminaries of Scottish and English geology may have received their international acclaim, but what of Ireland's geologists? If an international jury was empanelled to select the 'top twenty' geologists born in the British Isles before 1850, then surely there would be little dissent; figures such as Lyell, Murchison, and Sedgwick must be automatic choices, but the sole Irish candidate possessing even an outside chance of inclusion would be Sir Richard Griffith, 'the father of Irish geology'. Irish geologists are largely unknown outside their native land; the story of Irish geology has yet to be written (1). To some extent - and this must be freely admitted - the historians' neglect of Irish geology reflects the failure of Irish geologists to match the perspicacity so evident in the work of their contemporaries on the opposite side of the Irish Sea (2). There is, nevertheless, another reason for the story of Irish geology having been left in limbo. Those British historians who have chronicled the development of geology have hailed from either Scotland or England - Sir Archibald Geikie from Edinburgh, for instance, or London-born Horace B. Woodward - and understandably they have focussed their attentions upon the national traditions to which they themselves were heir. In the absence of any Irish historians of the earth-sciences, it follows that the modest Irish tradition in that field has passed largely unnoticed. Indeed (and here I may be doing little more than displaying a characteristic Irish propensity towards a persecution complex) if we take that most influential of all works in its field, Geikie's *The Founders of Geology* (1905), can we perhaps detect a tendency to introduce Irish geologists into the story chiefly as figures of ridicule (3)?

It is the object of this present essay to effect a modest remedy of the existing situation by drawing attention to the more important early Irish contributions to the literature of the

earth-sciences - contributions which seem to be little known outside their native island.

The Dublin Philosophical Society 1683-1697

The earliest serious Irish interest in geological phenomena was evinced by the members of the Dublin Philosophical Society, founded in 1683 during an Irish wave of enthusiasm for the New Philosophy. The society - it was closely associated with Trinity College, Dublin - may have been short-lived - it was in abeyance between 1687 and 1693 before finally expiring in 1697 - but its members were resolved that their observations of the natural world should be accorded permanence through the printed word. They never aspired to a journal of their own, but they did send many of their papers to London for inclusion in the Royal Society's *Philosophical Transactions*. A complete listing of those papers here is unnecessary; there is already extant the bibliography by Theodore Hoppen (4). Four of the papers do nevertheless deserve to be highlighted and they will also avail as illustrations of their genre.

First, there is a paper of 1685 by the Rev. William King (1650-1729), later Archbishop of Dublin, on the Irish bogs (5), a subject which he saw as one of national significance because, he noted, "We live in an Island almost infamous for Bogs". From him there came a vigorous plea for the drainage and reclamation of the bogs, although scientifically the most interesting part of the paper is the tailpiece wherein King discusses the hydrology of the turloughs, those ephemeral lakes which are so distinctive a feature of the limestone districts of Clare and Galway.

Second, I take a paper of 1694 on the Giant's Causeway by the Rev. Samuel Foley (1655-1695) and Thomas Molyneux (1661-1733)(6), the latter gentleman observing that the Causeway must be classed as one of the most remarkable natural curiosities in Europe - a feature which must have achieved far greater fame had it lain "in any of these more civilized Parts of the World". To the modern reader it seems strange to find Molyneux seeking, in the following terms, to prove that the Causeway is a natural feature and not man-made:

> "...there is not the least sign of morter, or any equivalent Cement to Joyn the Commissures or Sides of the Columns together; that there are no foot-steps of the strokes of Tools or Chissels, in the Surface of any part of the Stone."

The third paper is also by Thomas Molyneux: his discourse upon the so-called Irish Elk and its fossil remains (7). He

suggested that the extinction of the creature had been caused not, as some thought, by the Noachian Deluge, but by "a certain ill Constitution of Air in some of the past Seasons long since the Flood, which might occasion an Epidemick Distemper". The survivors of this murrain, he suggested, must have been exterminated by human hunters, and had Thomas Molyneux been alive today he must surely have taken his stand among the animal conservationists, because of the final disappearance of this giant deer he wrote:

> "Or had those Barbarous Times been capable of taking Care for the Preservation of this stately Creature, our Country would not have entirely lost so singular and beautiful an Ornament."

The final paper from the *Philosophical Transactions* to earn a mention here is by Thomas Molyneux's brother William (1656-1698) who was the real founder of the Dublin Philosophical Society. The spring of 1697, we are told, was unusually wet, and on the evening of 7th June a bog-burst occurred near Charleville, Co. Cork, the resultant debris burying a neighbouring meadow to a depth of 16 feet. William Molyneux wrote an account of the event for the Royal Society and thus became one of the earliest authors to describe such a mass-movement phenomenon (8).

One other essay emanating from Ireland in the 1690s must be cited. In 1699 one Richard Prior, a landowner in Queen's County (now County Leix), wrote for Robert Hooke, the Curator of Experiments to the Royal Society, an excellent pioneer account of that most distinctive of all Irish landforms - the esker (9). The esker in question lies near Portlaoighise (then Maryborough), and Prior describes its sinuous form as being some 12 miles in length, "the Sides so steep, that in most places not easy to ride up."

> "It is compos'd altogether of small rough Pebble grayish Stones about the bigness of a Mans Fist, and other smaller ones mix'd with Sand or Gravel, but no mixture of Clay or Loam, as this Author ever observ'd, which several times he sought after as he travell'd that way."

He found the origin of the ridge elusive, but he observed:

> "So that it should seem probable that this Ridge of Pebble and Sand was brought from some remote places by some violent motion of Waters, and dispos'd into the form it now remains in, which induc'd the Author several times to say, he believ'd it to be the effects of Noah's Flood, the Consideration whereof he refers to better Judgments."

The Physico-Historical Society 1744-1756

On 14th April 1744 a group of gentlemen assembled in Dublin to discuss a problem. They shared a belief that Ireland's resources were inadequately known and that many of the existing accounts of their native land were grotesque caricatures of reality. In order to rectify this situation they resolved to found a Physico-Historical Society which would organise the collection and publication of useful information about Ireland on a county basis (10). A questionnaire seeking information about topics ranging from notable echoes to the breeding habits of eagles was circulated widely; to the counties selected for study there were despatched paid itinerant investigators instructed to collect all manner of useful intelligence; and all this work was financed by the society's members paying an annual subscription of not less than one crown apiece. It was an ambitious project, and the members believed that their efforts would not only improve the public knowledge of Ireland, but also assist in the enrichment of the Irish economy through the discovery of hitherto unknown natural resources. A similar scheme for a county survey devised by William Molyneux in the 1680s had been something of a flop (11), but the Physico-Historical Society could soon show tangible evidence of its efforts. Between 1744 and 1750 comprehensive surveys of three counties - Down, Waterford, and Cork - were published with the society's imprimatur, and in 1756 - seemingly after the society's demise - there appeared a survey of Kerry "undertaken with the approbation of the Physico-Historical Society" (12). Behind these works there stood a single enthusiastic topographer - Charles Smith (1715?-1762), a native of Waterford city who followed the profession of apothecary at Dungarvan. Much of the information that he collected may seem quaint to the modern reader, but Smith's industry is impressive and his volumes are still eminently readable, although some critics do warn us that the character of his regional descriptions may vary according to the style of the hospitality that he received there while conducting his field investigations (13)!

All four of the county surveys contain chapters with a title such as 'Of the most remarkable Fossils discovered in this County' (that chapter in the Cork survey runs to more than thirty octavo pages) and therein Smith presents a great deal of information about both solid and drift phenomena, with the emphasis being upon deposits of economic significance. 'Soils, earths, and clays', 'marles', 'ochres or painting earths', 'coal', 'stones, slates, and marbles', 'fossil shells', 'spars, petrifactions, and crystals' - all are considered, but the material is presented essentially as 'point information' and there is little attempt to extrapolate the point information into any kind of regional synthesis. But

Smith was by no means oblivious to the possibility of such regional synthesis. In the Kerry survey of 1756 (14) he observed:

> "From hence it appears, that the several substances beneath the surface of the earth, are ranged with more order and regularity than has been hitherto taken notice of, and that they are not scattered at random but are joined together in different ranges, so that they may be traced from one county to another: and if ever the whole of this island comes to be accurately surveyed, it would not be very difficult to construct a map, whereon, by means of proper characters, its various soils might be expressed. This kind of inquiry might open an extensive field to geographers, and naturalists; and might form a connection between the two sciences, which are more dependant on each other in reality, than they have been hitherto supposed to be; and may give great light to the industrious searcher into minerals, and fossils, who, by knowing the true direction of any of these beds, may discover the same kind of matter as limestone, coal, slate, and several other metals at great distances from the place of their first appearance."

Smith was clearly an imaginative thinker in the then novel area of geological cartography, but more than eighty years were to elapse before there was published a geological map of Ireland of the type he envisaged (15). Smith himself, however, does have some claim to pioneer status as a geological cartographer. His survey of Co. Cork is accompanied by a map of the county at a scale of three and a half miles to the inch whereupon Smith has in a number of places inscribed the letters 'L.V.'. From the key we learn that these letters denote the long, narrow, limestone-floored vales which are such a distinctive feature of Munster's ridge and valley province. The ubiquitous Irish bogs had been represented after a fashion upon a number of earlier maps, but Smith's 1750 sheet of Co. Cork is evidently the earliest map attempting to show any aspect of Ireland's solid geology. Smith also has another 'first' to his credit: in the Co. Down survey of 1744, he and his co-author, Walter Harris (1686-1761), wrote of the county's drumlin-swarm landscape as looking like "wooden Bowls inverted, or Eggs set in Salt" (16). This was evidently the earliest version of the term now applied to landscapes of drumlinised drift, namely 'basket of eggs topography'.

Geological Museums 1766-1812

Despite the efforts of Charles Smith and the Physico-Historical Society, the earth sciences did not really command much Irish attention during the first half of the eighteenth century. By the 1760s, however, things were changing and one of the earliest signs of a revived interest in geology was the assembly of both private and public collections of minerals, rocks, and fossils. Among the earliest of the Irish collectors was the remarkable Frederick Augustus Hervey (1730-1803), the Bishop of Derry and fourth Earl of Bristol (17). A visit to Vesuvius in 1766 in company with that redoubtable student of the volcano Sir William Hamilton (to the world at large he is better remembered as the husband of Lord Nelson's Emma) whetted Hervey's appetite for things geological, and even a severe arm injury inflicted by a Vesuvian volcanic bomb failed to diminish his new-found enthusiasm. He remained a devoted collector in the science until 1778, when the fickle side of his character came into evidence with the sudden discovery that the collecting of expensive works of art was really more to his taste. But long before then Hervey's experience of an active volcano in Italy, and of extinct specimens in Auvergne, had led him to conclude that the Giant's Causeway could only be yet another part of Vulcan's empire. For a while he employed an Italian artist to make sketches at the Giant's Causeway and other Irish sites of geological significance, and it would be interesting to know whether any of these illustrations still survive.

A second Irish student of Vesuvius was the Rev. George Graydon (1753?-1803), a graduate of the University of Dublin of 1774 vintage. He paid a prolonged visit to Vesuvius in the spring of 1791 and there he assembled a large collection of rock specimens which he hoped would both shed light upon the geological history of Co. Antrim, and help to resolve the controversy then raging between the Neptunists and the Vulcanists (18). Some of his material he presented to the museum of his alma mater; the rest went to the museum of the Royal Irish Academy (19) whence it passed into the museum of the Dublin Society in 1801 (20).

General Charles Vallancey (1726-1812) was a third Irish collector (21). He was the proud owner of an extensive mineral collection (22) and in 1803 he wrote of the "study of Mineralogy having become almost general in this country of late years, and particularly with the members of the Dublin Society" (23). One of his contemporaries seriously looked forward to the establishment of small mineralogical societies in every provincial city of Ireland (24). Such expectations were never fulfilled, but in Belfast the young Belfast Library and Society for Promoting Know-

ledge (it was originally called the Belfast Reading Society), founded in 1788, certainly did take steps to establish a geological cabinet (25), and in Cork the (Royal) Cork Institution, inaugurated in 1803, had soon assembled a mineralogical collection by purchase and by gift (26). The two largest Irish collections were nevertheless in the capital - in Trinity College and in the Dublin Society, and these appear to be the only two Irish collections for which catalogues were published during our period.

The geological museum in Trinity College is said to have been founded by the Rev. William Hamilton (1755-1797) who was elected to a Trinity Fellowship in 1779. The first catalogue of the museum was published in 1807 (27), having been prepared by the curator, Whitley Stokes (1763-1845) (a few years earlier he had been in bad odour with the authorities as a member of Wolfe Tone's United Irishmen), in association with another Trinity graduate, the Rev. Walter Stephens (1772?-1808), who in 1812 was the author of a posthumous work (28) on the geology of the Dublin region. In 1807 the museum was arranged in three sections: systematic mineralogy, consisting of 1089 specimens, this being the only section fully described in the catalogue; the geological collection, containing a variety of different rock types; and the geographical collection, in which, on a regional basis, there was displayed material from various parts of the world, the assemblage including Graydon's specimens from Vesuvius.

The geological collection of the Dublin Society contained an undoubted chef d'oeuvre: the famed Leskean cabinet of minerals. Originally assembled in Germany by Nathanael Gottfried Leske (29), the cabinet, containing 7331 minerals, had been purchased by the Dublin Society in 1792 for the princely sum of £1350 (30). In the society's Dublin premises (the society was then located in Hawkins Street) the collection was arranged under the expert guidance of Richard Kirwan (1733-1812), one of the world's leading mineralogists, and George Mitchell (1766-1803) translated Karsten's catalogue of the collection into English, the catalogue being published in two volumes in 1798 (31). When the young Robert Jameson (later he was to hold the Edinburgh chair of Natural History for fifty years) visited Dublin from Scotland in 1797 he devoted no less than eight days to the study of the great collection (32), but today, sadly, there are very few under the age of sixty who have so much as seen a single Leskean specimen. Early in the present century what remained of the Leskean collection was on display in the National Museum, but in June 1922 it was swept from its gallery to make way for the civil servants necessary to service the newly-independent Irish Free State. At present the minerals lie in packing cases in the store-rooms of the former Royal Hospital at Kilmainham, Dublin (33).

Geological Visitors to Ireland 1776-1812

Another sign of the late-eighteenth-century revival of interest in geology was the arrival in Ireland of many a visitor who had more than a passing concern for the rocks to be seen in the Irish countryside. There is nothing to suggest that any part of Ireland experienced a geological invasion comparable with that of the English Lake District, where as early as 1814 Wordsworth entered a vigorous protest against the activities of the self-styled "brethren of the hammer" (34). Nevertheless during the closing decades of the eighteenth century Irish rocks must have rung frequently under the blows of visiting hammers. One of the earliest of the geologising visitors was Arthur Young (1741-1820). During his Irish tour of 1776 he collected a number of geological specimens, although his efforts were rendered somewhat futile because on his return to England the trunk containing his samples was stolen somewhere between Bath and London (35). On opening his booty the thief must have been disappointed to discover that he held nothing more exciting than lumps of rock, a few bags of soil, and some samples of best Irish turf!

John Wesley's (1703-1791) many preaching tours through the length and breadth of Ireland can hardly be regarded as geological peregrinations, but he did, on 6th June 1778, visit the Giant's Causeway, there to arrive at an impeccable conclusion: "It is doubtless the effect of subterraneous fire" (36). The reasoning behind his invocation of the igneous forces was as follows:

> "This manifestly appears from many of the stones which composed the pillars that are now fallen down; these evidently bear the mark of fire, being burnt black on one or the other surface. It appears likewise from the numerous pumice-stones scattered among the pillars: just such pillars and pumices are found in every country which is, or ever was, subject to volcanoes."

Another visitor to the Causeway - and this time a geologist of real repute - was a Cheshire-born horologist and member of Birmingham's famed Lunar Society - John Whitehurst (1713-1788). He toured Co. Antrim in 1783, and to the second edition of his *Inquiry into the Original State and Formation of the Earth* he added a series of observations relative to that county's basalts. These he regarded as unequivocally of volcanic origin (37):

> "Amongst the numerous vestiges of ancient volcanos, I presume there are few more stupendous than those on the northern coast of Ireland, though no visible crater is now remaining be-

> tween Port Rush Strand and Balley castle eastward... the cliffs are indeed stupendous, and bear every possible mark of their having been originally liquid fire."

He in the following manner (38) explained the absence of any obvious vent from which the lavas could have flowed:

> "...the crater from whence that melted matter flowed, together with an immense tract of land towards the north, have been absolutely sunk and swallowed up into the earth, at some remote period of time, and became the bottom of the Atlantic ocean."

A second member of the Lunar circle to visit Ireland in 1783 was Matthew Boulton (39), but he merely collected Irish minerals without ever essaying into print with his geological experiences. More substantial were the investigations made by Abraham Mills during the course of two Irish tours in 1787 and 1788 (40). Mills, an English mine manager with interests in the Wicklow copper mines, focussed his attention principally upon Co. Antrim where he, too, correctly identified the widespread evidence of former volcanic activity. Two days of study at the Giant's Causeway led him to a perceptive observation:

> "...the red ochry joints between the beds of rude lava, and the different heights at which the basalt pillars are seen, give probability to the conjecture, that the whole mass has been the produce of several successive eruptions."

The Wicklow copper mines, in which Mills had an interest, also attracted the attention of a French visitor - Baron Charles-Etienne Coquebert de Montbret (1755-1831), who in 1789 was appointed Agent Général de la Marine et du Commerce de France en Irlande (41). He travelled widely in Ireland in 1790 and 1791 publishing some of his geological observations in the *Journal des Mines* (42).

During the Napoleonic War British geologists were largely excluded from the continent of Europe and some of them, impatient for fresh geological experiences, turned westwards to Ireland. John Playfair (1748-1819), from Edinburgh, crossed the North Channel around 1802 (43), his prime objective being Portrush where the Rev. William Richardson (1740-1820) claimed to have found fossils in what he termed "a silicious basalt" (44). If Richardson was right, then the Volcanic Theory must yield to the Neptunian, but Playfair had little difficulty in confirming that Richardson

had failed to discriminate between the igneous rock of the Portrush sill itself and the adjacent indurated, but fossiliferous shales (45). Two other geological visitors of renown were Humphry Davy and George Bellas Greenough, the first President of the Geological Society of London. Davy geologised in Ireland during the summers of 1805 and 1806 (46), and in the latter year Greenough was his travelling companion. Irish rocks must have appealed to Greenough because he returned to Ireland in 1807 and 1813, and some of his Irish field observations later found their way onto the pioneer manuscript geological map of Ireland which Richard Griffith displayed at the Dublin Society in the spring of 1814 (47). In view of his Irish activities, it is not entirely inappropriate that Greenough's whalebone-handled geological hammer should eventually have found a place among the treasures of Dripsey Castle, Co. Cork. The hammer was certainly there in 1907, the property of Mrs Bowen-Colthurst (48), but was it still at Dripsey when the house was destroyed during the Irish Troubles in the 1920s?

In concluding this survey of Ireland's early geological visitors I want to step outside the strict temporal limits of this paper to mention what seems to have been the earliest lady visitor to geologise among Ireland's rocks. She was Miss Anne Plumptre, a daughter of the President of Queen's College, Cambridge, and, surprisingly, a devoted admirer of Napoleon. She toured Ireland during the summers of 1814 and 1815 (49) and made many geological observations, being accompanied by a manservant who was himself an enthusiastic mineralogist. While in Dublin she visited Trinity College - the College museum was one of her objectives - but in her account of the occasion she made some comments about the Vice-Provost, the eccentric John Barrett, which he regarded as offensive. In consequence, when Miss Plumptre's book arrived in the College library, Barrett refused to permit its addition to the collection as a work "too silly & too ill mannered for a public library" (50). Fortunately he was overruled by the Board of the College.

Geological Theory 1786-1812

The two closing decades of the eighteenth century saw the development of an Irish interest in the broader aspects of geological theory, an interest which was centred upon Trinity College and upon the Royal Irish Academy, which was founded in 1785. Three figures were principally involved: William Hamilton, Richard Kirwan, and William Richardson.

William Hamilton, we are told, turned to the study of geology soon after his election to a Trinity College Fellowship in 1779, and as we saw earlier, he is reputed to have been the

founder of his University's geological museum. To equip himself the better in his chosen field, he in the summer of 1784 visited northern Co. Antrim and his observations thereupon were published in 1786 (51). He was a follower of Desmarest and the Vulcanist School, and like so many others who had visited the north-east, he concluded that the basalts could only be a legacy of former igneous activity. This opinion he supported with powerful arguments, although he admitted that it was an opinion which left him with a sense of awe (52):

> "If the volcanic theory of the basaltes be well founded ... a scene of horror is presented to our view, which must surely fill us with astonishment; since on this system it will be found, that there is hardly a country on the face of our globe which has not at some time or other been wasted by the fury of subterranean fire."

The map accompanying the first edition of Hamilton's volume, and depicting the coast of northern Antrim between Fair Head and Portrush on the one-inch scale, is a document of some significance because if we disregard those L.Vs. inscribed upon Smith's 1750 map of Co. Cork, then Hamilton's map must be acclaimed as the first serious attempt at a mapping of the geology of any part of Ireland. Clusters of tiny circles are used to represent outcrops of columnar basalts; along the coast the words 'Lime Stone' are inscribed to show the presence of Cretaceous chalk; line-shading is employed to depict what are presumably peat-bogs; and stippling is used to represent areas of blown-sand near Bushmills and Portrush. A rudimentary map it may be, but its pioneer status gives it considerable interest. Perhaps, too, there is a certain morbid fascination in the fact that in 1797 Hamilton was murdered not so very far off the map's western margin.

Richard Kirwan, Copley Medallist of the Royal Society (1782) and second President of the Royal Irish Academy (1799-1812), was a mineralogist possessed of an international reputation based upon his *Elements of Mineralogy* (53) first published in 1784. The second edition of this work, published in 1794-96, was much influenced by the presence in Dublin of the Leskean cabinet, and it was, incidentally, in this second edition (54) that Kirwan coined the term 'Plutonic System' to describe the Huttonian Theory. Mineralogy may have been his first love, but in the 1790s he extended himself from mineralogy into the far more treacherous territory of earth history. In a paper read to the Royal Irish Academy in 1796, and in his *Geological Essays* of 1799 (it was first published in German because the English edition was delayed by the outbreak of the 1798 rising in Ireland), he

emerged as a thoroughgoing Neptunian convinced of something close to the literal truth of the so-called Mosaic writings (55). For Kirwan many mountains were merely great crystalline structures formed by precipitation in a primordial fluid, granite and basalt were of aqueous origin, and most of the earth's topography was a result of shocks administered to the continents by the surging torrents of the Noachian Deluge. Galway Bay, he claimed, was the site of a granite mountain shivered during the diluvial catastrophe, and he even regarded the columnar structures of the Giant's Causeway as basalts "rent into pillars" by the same cataclysm (56). It was all heady stuff, strongly reminiscent of the theories of the earth devised in the late seventeenth century by Thomas Burnet and William Whiston, and Kirwan was quite out of touch with the stratigraphical approach to earth-history soon to be employed to such brilliant effect by the English school of geology.

One of his biographers has observed of Kirwan: "Scarcely ever did he advocate a theory, which was not almost immediately discovered to be unfounded" (57). Such a verdict holds much truth, and perhaps Kirwan's most significant role in the history of the earth-sciences was as a foil to Scotland's James Hutton. On 3rd February 1793 Kirwan presented to the Royal Irish Academy a critique of the Huttonian Theory as it had appeared in the *Transactions of the Royal Society of Edinburgh* of 1788 (58). Hutton's Edinburgh friends had been urging him to publish a more extended account of his theory, but ill-health had supervened and there seemed to be little hope of the revised theory ever being completed. The entreaties of his friends may have failed, but Kirwan's essay did the trick; an incensed Hutton was stung into action and as a result the world was given a classic of scientific literature - Hutton's two-volume *Theory of the Earth* of 1795. Indeed, the final repercussions of Kirwan's attack will be felt in 1978 because some of the illustrations which were to have accompanied the extended version of Hutton's *Theory* were lost, only to be rediscovered recently and they are scheduled for publication this year.

William Richardson was mentioned earlier because of his supposed discovery of 'marine exuviae' in the Portrush sill during or before 1799. He had been elected to a Trinity College Fellowship as far back as 1766, but he seems to have turned to geology rather late in life and it was not until after 1800 that there began to come from his pen a steady stream of geological papers and pamphlets, most of them reflecting an intimate knowledge of the rocks of northern Co. Antrim where he lived at Portrush for a part of each year (59). Virtually all of his publications had the same objective: opposition to the Volcanic Theory of Desmarest and the Plutonic Theory of Hutton. He himself protested that he subscribed to no particular school of geological thought, but he

clearly leaned towards the Neptunian viewpoint. He admitted that he had never seen a volcano, but this was no deterrent to his vigorous denial of an igneous origin for the Antrim basalts. In seeking to counter the Vulcanists and Plutonists, he adduced a good deal of not always very convincing geological evidence, but the real reason for his opposition to these theories was not geological so much as theological. He deplored what he saw as the subversive influence of modern geology, and he viewed the likes of Desmarest and Hutton as the members of an international conspiracy designed to overthrow the Christian faith by shedding doubt upon both the early chapters of Genesis and the Old Testament belief in the novity of the universe.

The igneous origin of the Antrim basalts had been so widely admitted before the 1790s that it comes as something of a shock to find geologists of the standing of Kirwan and Richardson rejecting the volcanic interpretation in the years around 1800. Many factors doubtless contributed to their stand, and among them the political events of the 1790s may well have played a part. During that decade the excesses of the French Revolution caused widespread alarm in Britain. All ideas emanating from France, and seemingly subversive of religion and the established order, were viewed with abhorrence by the establishment. Such sentiments were general throughout the British Isles, but they may well have been particularly pronounced in Ireland where the established order must have seemed especially fragile. William Hamilton's murder by a Donegal mob in 1797 took place because he happened to be the local magistrate, and in the following year Ireland was torn asunder by a French-backed rebellion. Kirwan and Richardson both lived through these events and is there any wonder that the latter, a priest in the established but minority church, should have seen himself as threatened by the French-inspired 'atheistical tendencies' of modern geology? The relationship between political events and Irish scientific developments is certainly a field in need of further investigation.

Economic Geology 1786-1812

If Irish interest in the theoretical aspects of geology was focussed upon Trinity College and the Royal Irish Academy, then it was upon the Dublin Society (60) that there became focussed the Irish interest in economic geology. Some concern for geology as a key to Ireland's natural resources had been evident elsewhere, and not least among the members of the Physico-Historical Society, but it was at the Dublin Society in the 1780s that a really keen interest in economic geology first came into evidence. Ireland was beginning to suffer from that population pressure which was to become so acute in the following century, and understandably Irish landowners started to cast envious eyes across the water to England where the Industrial Revolution was init-

iating the creation of a new national wealth of unprecedented magnitude. Was there a possibility, they wondered, that buried in Ireland's rocks there were mineral riches sufficient to trigger and sustain an Irish Industrial Revolution? Might the serious pursuit of geology perhaps yield great rewards for their impoverished kingdom? It was in the summer of 1788 that one tourist through Ireland reported that he had found "the attention of many of the principal landholders awakened to researches after minerals" (61). This was the search which the Dublin Society now sought to foster.

As early as 1772 the Dublin Society awarded a premium of £50 to John Rutty (1698-1775), a Dublin physician, for a natural history of Co. Dublin comparable with the county surveys issued earlier under the auspices of the Physico-Historical Society (62). Indeed Rutty had been commissioned by that society to write an account of Co. Dublin as far back as 1745, and his eventual volumes of 1772 (63) contain an elementary description of the county's economic geology covering such topics as soils, sand and clay deposits, mineral resources, and peat supplies. Dublin, however, is only one of thirty-two counties, and the Dublin Society was anxious to expedite the surveying of the nation's mineral resources. In 1786, therefore, it appointed Donald Stewart, a Scotsman, as the society's Itinerant Mineralogist at a wage of one guinea per week, his first assignments being to investigate both the geology of Co. Wicklow and the exposures revealed along the Grand Canal between Dublin and the Shannon (64). Other assignments soon followed, and over the years, until his death in 1811, he visited most parts of Ireland and his published report of 1800 describes in rudimentary fashion the economic geology of twenty-five of the Irish counties (65).

Although the Dublin Society was well satisfied with Stewart's work - in 1808 his wages were doubled - the members were soon contemplating a new and more elaborate surveying project. Between 1791 and 1799 Sir John Sinclair had published a parochial survey of Scotland in twenty-one volumes, while in England and Wales, between 1793 and 1817, the Board of Agriculture was at work producing a series of county agricultural surveys. The Dublin Society was determined that Ireland should not be outdone. In 1800 the soon-to-be extinguished Irish Parliament authorised the Dublin Society to expend a portion of its government grant "in producing agricultural examinations into all or any of the counties of this kingdom". Both Charles Vallancey and Richard Kirwan were active in the initial organisation of the project, and eventually surveys were published for twenty-three of the thirty-two Irish counties, the reports appearing between 1801 and 1832 (66). The surveys are primarily agricultural in character, but many other topics are considered and the society's *Suggestions of*

enquiry for gentlemen who shall undertake the forming of agricultural surveys (67) recommends prospective authors to devote attention both to 'soil and surface' and to 'minerals'. The authors heeded this advice; some of them offered comprehensive surveys of their county's solid geology and four of them even provided coloured geological maps in illustration of their texts (68). Hitherto historians of the earth-sciences have almost completely overlooked the existence of these essays in regional geology (69), an oversight doubtless to be explained by the fact that many of the reports were printed only in small editions (70) and in consequence they are now rare even within Ireland itself.

In the present context one of the county surveys surpasses all the others in its interest - William Tighe's survey of Co. Kilkenny published in 1802. Tighe was born in 1766, the son of William Tighe of Rosanna, near Rathnew in Co. Wicklow, and in later life William Tighe junior lived at Woodstock House near Inistioge, Co. Kilkenny. He was educated at Eton and St. John's College, Cambridge; from 1790 until 1800 he was a member of the Irish Parliament, and from 1806 until his death in London on 19th March 1816 he sat for Co. Wicklow in the Westminister Parliament. The highlight of Tighe's survey is a splendid coloured geological map of Co. Kilkenny at a scale of 2.5 miles to the inch, a map which in its day was the most ambitious example of geological cartography to have been published within the British Isles. The construction of a geological map involves two basic processes. Firstly each of the rock-types present in the area must be identified, and secondly, the limits of the various rock-types must be traced in the field and plotted upon the map. Tighe has performed both these tasks with remarkable success. Indeed, the excellence of his map in both conception and execution poses a problem. How did Tighe come to possess the insight and expertise to produce such a work? Had the map come as the culmination of a long period of personal geological study, then its outstanding merit might have been understandable, but there is no evidence that Tighe ever served such a geological apprenticeship. The map and its accompanying text are the only known evidence of his interest in the earth-sciences, and they appear upon the scene as a brilliant and quite unheralded flash in the Irish geological pan. We need to know more about this remarkable man.

On 4th June 1812 the Dublin Society decided to create the new post of Mining Engineer, and on the following 12th November there was elected to the office a young Irishman who was destined to enjoy a career of the utmost distinction in the public service - Richard Griffith (1784-1878). His election marked the dawn of a fresh era in the story of Irish geology, and the event must also mark the end of our present survey.

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the Dublin Society in the years 1803, 1804 & 1805 in the Countys of Kilkenny, Waterford & Tipperary; five volumes entitled *Catalogue of Minerals,* c. 1797-1800, and listing 3095 specimens collected in 15 Irish counties. Some of his work also appeared in Joseph Archer's *Statistical Survey of the County Dublin,* Dublin 1801, pp. 248-259. See also K. Dillon, Donal Stewart and the mineral survey of Co. Clare, *North Munster Antiquarian Journal,* 1953-57, 7: 187-196.

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Professor Gordon L. Herries Davies, Department of Geography, Trinity College, Dublin.

SHORT NOTES

WHITE-SIDED DOLPHIN STRANDED IN ARGYLL

A fresh specimen of the White-sided Dolphin *Lagenorhynchus acutus* was found dead at the Point of Knap, Knapdale, on 17th October 1978. Excellent photographs have been supplied by Mrs D.M. Hootton. The carcase was removed to the Royal Scottish Museum in Edinburgh where it was dissected by Dr. Arthur S. Clarke, Keeper of the Natural History Department; the specimen of the skull has been retained in the Museum. As readers would see from the recent paper on the Marine Mammals of the Clyde area (*Western Nat.*, 5: 3-39; 1976), this is the first authentic specimen of the White-sided Dolphin to be obtained from land adjoining the Clyde. To the best of my knowledge there is still no authentic record from the Clyde sea area. J.A. Gibson

LEATHERY TURTLE ON JURA

A specimen of the Leathery Turtle (or Luth) *Dermochelys coriacea* came ashore on the west shore of Jura in 1978. It was apparently dead when first discovered around the end of September. Excellent photographs of the specimen were taken by Mr. Tony Newberry, who was on holiday on Jura at the time. Unfortunately the specimen was apparently towed out to sea by a local lobster fisherman before a full investigation of the carcase could be made, but the photographs place the identification of the specimen beyond doubt and several copies of the photographs have been lodged in the Royal Scottish Museum, Edinburgh.

Although some earlier occurrences have since come to light, the first fully-authenticated Scottish specimen of the Leathery Turtle was obtained in the Kilbrannan Sound, off Arran, in August 1959 (*Scot. Nat.*, 1961: 45-46) and only very few occurrences have been reported since, so this additional record is of considerable importance. From discussions with several local residents who saw the turtle, the Rev. Mr. Peter Youngston, Minister of Jura, managed to establish that this 1978 Jura specimen was over five feet in length. J.A. Gibson

LARGE PIKE IN LOCH FAD, ISLAND OF BUTE

As interested readers would see from the recent paper by Dr. J.A. Gibson and Mr. Alex. Stephen on the Freshwater Fishes of the Island of Bute (*Trans. Buteshire Nat. Hist. Soc.*, 20: 71-75; 1976) very large Pike *Esox lucius* of up to nearly 30 lbs in weight have been recorded from Loch Fad over the years, but some recent additional information has now come to light. On 6th August 1978 Rothesay Seafoods Ltd caught a 25½lb Pike in Loch

Fad, and during 1974 the hauling of a salmon net shot along the shore of the loch revealed sixteen Pike ranging from 9 lb to 27½ lb in weight. For this additional important information I am very grateful to Mr. Thomas S. Rae, Director of Rothesay Seafoods Ltd.

J.A. Gibson

NOTES ON THE LEPIDOPTERA OF SANDA ISLAND, KINTYRE

During the summer of 1977 I made an attempt to collect some of the lepidoptera I had seen on Sanda during my visits there on bird-ringing expeditions. Many of the specimens were found around the lighthouse by the 'keepers and passed on to me. A small number of these specimens were so abraded as to be unidentifiable, but those that could be identified positively totalled six butterflies and twenty moths, as follows:

Butterflies:

Green-veined White	*Pieris napi* L.
Common Blue	*Polyommatus icarus* (Rott.)
Small Tortoiseshell	*Aglais urticae* (L.)
Scotch Argus	*Erebia aethiops* (Esp.)
Small Heath	*Coenonympha pamphilus* (L.)
Meadow Brown	*Maniola jurtina* (L.)

Moths:

Map-wing Swift	*Hepialus fusconebulosa* (Deg.)
Transparent Burnet	*Zygaena purpuralis caledonensis* Reiss.
Six-spot Burnet	*Z. filipendulae anglicola* Trem.
Large Emerald	*Geometra papilionaria* (L.)
Common Carpet	*Epirrhoe alternata* (Müll.)
Yellow Shell	*Camptogramma bilineata* (L.)
Northern Spinach	*Eulithis populata* (L.)
Netted Pug	*Eupithecia venosata* (Fab.)
Treble Bar	*Aplocera plagiata* (L.)
Scotch Annulet	*Gnophos obfuscatus* (D. & S.)
Common Footman	*Eilema lurideola* (Zinck.)
White Ermine	*Spilosoma lubricipeda* (L.)
White-line Dart	*Euxoa tritici* (L.)
Lesser Yellow Underwing	*Noctua comes* (Hübn.)
Marbled Coronet	*Hadena confusa* (Hufn.)
Antler Moth	*Cerapteryx graminis* (L.)
Smoky Wainscot	*Mythimna impura* (Hübn.)
Dark Arches	*Apamea monoglypha* (Hufn.)
Flounced Rustic	*Luperina testacea* (D. & S.)
Haworth's Minor	*Celaena haworthii* (Curt.)

I am grateful to Mr. Thomas Daniels for assistance with the identification.

Edward J. Maguire

REQUESTS FOR INFORMATION

MONITORING OF BAT COLONIES IN CLYDE AREA

In conjunction with the Biological Records Centre at Monks Wood, Dr. J.A. Gibson, Clyde Area Recorder for the Mammal Society, is hoping to organise monitoring of bat colonies during 1979 and in subsequent years. Bats usually roost in the roofs of buildings or old trees, and most colonies likely to be monitored will be Pipistrelles. The easiest way to estimate numbers is to observe the bats flying out from the roosting colonies at sunset, and if necessary identification can be aided by catching one of the emerging bats in a butterfly net (not always as easy as it sounds!). Although the Pipistrelle, the Long-Eared Bat, and to some extent Daubenton's Bat, are fairly well distributed throughout the Clyde area, it is necessary to locate colonies which can be observed easily, and it will greatly assist the operation if anyone who knows of any bat colony, particularly one in a place easy to observe, would communicate with Dr. Gibson at Foremount House, Kilbarchan, Renfrewshire. A leaflet, "Focus on Bats", is available to all who are able to assist.

Alarming reports have recently been received about the gassing of colonies of bats. This is technically illegal, and local authorities and pest control firms should not now undertake such work. In any case, killing bats in dwelling houses is likely to create more problems than any possible problem living bats may be causing. Living bats do not present any sort of health hazard. It will be greatly appreciated if anyone who hears about the possible gassing of any bat colony will notify Dr. Gibson at once.

ABSENCE OF BREEDING TERNS IN CLYDE AREA

During the breeding season of 1978 Dr. J.A. Gibson and Mr. W.M. McMurtrie visited many of the old-established Common and Arctic Tern colonies throughout the Clyde area. Of fourteen very traditional sites visited, however, eleven held no terns at all, and one only had odd birds in the vicinity; breeding was recorded at only two sites and even there in very restricted numbers. This is a most remarkable change and observations will be continued during the next two breeding seasons. Offers of assistance will be gratefully received, and anyone who is likely to be able to visit Clyde tern colonies during 1979 or 1980 should communicate with Mr. McMurtrie at Ardyne, 21 Eastwood Avenue, Giffnock, Glasgow, G46 6LS (Telephone: 041-638-2152).

NOTICE

FRIENDS OF LOCH LOMOND

In the wake of the proposed plan to establish a hydro-electric power scheme at Craigroyston, Loch Lomond, readers may be interested to hear of a new society, Friends of Loch Lomond, which has been formed to protect Loch Lomond, its islands and the surrounding countryside. The membership subscription is £2 per annum, and application forms can be obtained from Mrs Hannah Stirling, Auchendarroch, Tarbet, Dunbartonshire G83 7DQ. This is clearly a very worthy venture, to which we are glad to give publicity.

THE RENFREWSHIRE NATURAL HISTORY SOCIETY

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The Renfrewshire Natural History Society is the oldest Natural History and Antiquarian society in the West of Scotland. It was founded by the late Morris Young F.E.S. on 18th December 1847, and is now one of the oldest County Learned Societies in Great Britain.

The Society deals with all aspects of the history, natural history, archaeology and antiquities of the county of Renfrewshire, and its general interests extend over the whole of the West of Scotland. Either directly or through members it is affiliated to most major natural history and archaeological organisations in the British Isles.

The Society meets regularly for lectures and discussions during the winter months, and during summer field meetings are arranged to places of natural history or archaeological interest. The Society publishes the *Western Naturalist*, periodical *Proceedings*, and a regular *Newsletter*. All publications, including the *Western Naturalist*, are sent to members free of charge.

The annual subscription for full membership is two pounds. Over 65, juniors, students, and family members: 25p.

Applications for membership should be made to the Secretary.

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